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VOL. CXXXV.—No. 3500] LONDON: FRIDAY EVENING, JANUARY 26, 1923 [PRICE { WITH INDEX AND OTHER SUPPLEMENT } 1s. 6D. BY INLAND POST 1s. 9d.

PUBLIC NOTICES

REINFORCED CONCRETE COMPETITION.

The Crown Agents for the COLONIES, acting on behalf of the Government of the Straits Settlements, invite COMPETITIVE DESIGNS for the REINFORCED CONCRETE WORK required in connection with the Construction of a New General Post Office at Singapore. Tentative designs, for which no fees will be paid, are required in the first instance, from which it is proposed to select a design and specify its adoption in the contract for the construction of the building.

The firm whose design is so adopted will be subsequently engaged to prepare full detail plans, specification, quantities, &c., for an approved fee.—Drawings can be seen and further details of the competition obtained from the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting Z/Straits Settlements, 5664. 1356

Harbour Engineer Re- QUIRED by the GOVERNMENT of MAURITIUS for **two years** in the first instance. Salary £1400 per annum without quarters. Free passage out and home. Candidates must have had suitable experience of general harbour work, especially survey, dredging and the design and construction of steel and ferro-concrete lighter wharves. —Apply at once, by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W., quoting M/11,793. 1358

Artillery College, Woolwich.

DEPARTMENT OF MECHANICAL AND ELECTRICAL ENGINEERING.

(PROFESSOR J. J. GUEST, M.A., M.I.M.E.).

APPLICATIONS are INVITED for the POST of SENIOR LECTURER in the Mechanical Engineering Section. Salary £500 to £600 per annum. Post is pensionable under the Federated Superannuation Scheme for Universities.

Applications should be made, in writing only, before 15th February, 1923, to the ADJUTANT, Artillery College, Red Barracks, Woolwich, S.E. 18, from whom further particulars can be obtained. 1329

University College of South WALES AND MONMOUTHSHIRE. COLEG PRIFATHROFAOL DEHEUDIR CYMRU A MYNWY.

An ENGINEERING SCHOLARSHIP, provided by the South Wales Institute of Engineers, of the value of £70 per annum, tenable for three years by a student who intends to enter some branch of the engineering profession, will be OFFERED for COMPETITION at the College Entrance Scholarship Examination, which begins on April 16, 1923.

Further particulars can be obtained from the undersigned, to whom the form of application must be returned on or before March 19, 1923.

D. J. A. BROWN, Registrar.

University College, Cardiff, December 29, 1922. 1315

The Norton and Gregory Annual SCHOLARSHIPS IN ENGINEERING.

Offered by NORTON and GREGORY, Ltd., London.

HONORARY COMMITTEE:

Sir JOSEPH PETAVEL, K.B.E., D.Sc., F.R.S., Director of the National Physical Laboratory, Teddington (Chairman).
Professor C. E. INGLIS, M.A., Professor of Engineering, Cambridge University (Vice-Chairman).
Professor E. G. COKER, D.Sc., F.R.S., Dean of the Faculty of Engineering, University of London, University College, Gower-street, W.C. 1.
J. TALBOT, Esq., T.D., M.A., B.Sc., Master of Haileybury College (Appointed by the Committee of the Headmasters' Conference).
G. H. BURKHARDT, Esq., M.A., M.Sc., Principal of Swindon and North Wilts Secondary School and Technical Institution, Swindon (Appointed by the Incorporated Association of Headmasters).
Together with the Chairman and the Managing Director of Messrs. Norton and Gregory, Ltd.

Messrs. Norton and Gregory, Ltd., offer Two Engineering Scholarships to be competed for annually, one value £100 per annum, and one value £50 per annum, tenable for three years at any University in the United Kingdom or British Dominions approved by the Committee.

A sum sufficient to cover the Scholarships now offered has been deposited by the Donors in the names of the Chairman and Vice-Chairman of the Committee.

Candidates must have reached the age of 17, but not the age of 19, on 1st March in the year of Examination, be domiciled in the United Kingdom, and undertake to pursue a three years' course in Engineering with a view to following it as a profession.

Papers, which will cover two days' Examination, will be set in the following four subjects:—

English,
Mathematics,
Mechanics,
General Physics.

The Examination for the 1923 Scholarships will be held in March at a date to be fixed later, and all Application Forms must reach the Committee not later than 15th February, 1923.

Full particulars and official Application Forms may be obtained from

The SECRETARY,
SCHOLARSHIPS COMMITTEE,
Messrs. Norton and Gregory, Ltd.,
1 and 2, Castle-lane,
Westminster, London, S.W. 1.
1364

Bombay, Baroda, and Central INDIA RAILWAY COMPANY.

The Directors are prepared to receive up to Noon on Wednesday, 7th February, TENDERS for the SUPPLY of :—

1. CAST IRON CYLINDERS, including BOLTS and NUTS, CAST IRON CAPS and GALVANISED BRACINGS.
2. WROUGHT IRON or STEEL PIPING, &c.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 20s. each for No. 1 and 10s. each for No. 2 (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG, Secretary.

Offices: 91, Petty France, Westminster, S.W. 1. 22.1.23. 1345

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

Symposium on Engine Indicators.

Cobalt Steels for Permanent Magnets—No. II.

Large Transporter for Ireland.

G.N.R. Three-Cylinder "Pacific" Passenger Engine (With a Two-Page Drawing).

20 Years of Diesel Engine Building.

Oily Ballast Separating Barge.

Machine Tools for Locomotive Work.

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PUBLIC NOTICES

Borough of Folkestone (Urban DISTRICT).
SEA OUTFALL.
TO IRONFOUNDERS.

The Corporation is prepared to receive TENDERS direct from Ironfounders for the SUPPLY and DELIVERY at Folkestone, Kent, of about 1110 TONS of CAST IRON PIPES and SPECIAL CASTINGS.

The pipes and special castings will range from 48in. to 12in. diameter, the principal sizes being 48in. and 36in.

Quantities may be obtained from the office of the Engineers, Messrs. W. H. Radford and Son, Albion Chambers, King-street, Nottingham, on deposit of Three Guineas (cheque), which sum will be returned on receipt of a bona fide Tender and the return of the quantities.

In case of firms employing more than 20 men preference will be given to those whose names are on the King's Roll of Honour.

The lowest or any Tender will not necessarily be accepted.

Sealed Tenders to be sent to the undersigned on or before February 8th, 1923, endorsed "Iron Pipes."

By Order,
A. F. KIDSON, Town Clerk.

Town Clerk's Office, Folkestone, 20th January, 1923. 1326

City of Leicester.
ADDITIONAL PUMPING MACHINERY AT ABBEY PUMPING STATION AND BEAUMONT LEYS SEWAGE FARM.

The Sewage Works and Farms Committee of the Leicester City Council invite preliminary PROPOSALS, DESIGNS and QUOTATIONS for STEAM, ELECTRICAL or other type of PUMPING MACHINERY in connection with the Sewage Disposal of the City.

Particulars, together with general conditions, outline specification, plans showing sites, &c., may be obtained at the City Surveyor's office on payment of the sum of £5 (Five Pounds), which will be returned on the receipt of a bona fide Proposal and Quotation.

Cheques, &c., to be made payable to the Leicester Corporation and sent to the City Treasurer.

Proposals and Quotations on the form supplied, addressed to "The Chairman of the Sewage Works and Farms Committee, Town Hall, Leicester," are to be delivered not later than Twelve Noon, Monday, 12th March, 1923, and endorsed "Pumping Machinery."

The Committee do not bind themselves to accept any Proposal of Quotation.

The acceptance of any Proposal and Quotation will be subject to the approval of the City Council and the Ministry of Health.

E. GEORGE MAWBEY, M. Inst. C.E., City Engineer and Surveyor.

Town Hall, Leicester, January, 1923. 1347

Great Northern Railway (Ire- LAND).
TO BRIDGE CONTRACTORS.

The Directors are prepared to receive TENDERS for the RECONSTRUCTION of a STEEL UNDERLINE BRIDGE near Omagh Station.

The drawing and specification may be inspected at the Engineer's Offices, Dublin and Belfast, and copies of same, together with bills of quantities and forms of Tender, may be obtained from the undersigned, on payment of Two Guineas, which will be refunded on receipt of a bona fide Tender.

Tenders, made out on the forms supplied by the Company, should be delivered, under sealed cover, endorsed "Tender for Bridgework," not later than 10 a.m. on Saturday, February 17th, 1923.

The Directors do not bind themselves to accept the lowest or any Tender.

J. B. STEPHENS, Secretary.

Amiens-street Station, Dublin, 24th January, 1923. 1369

PUBLIC NOTICES

City of Nottingham.
NORTH WILFORD POWER STATION.

RAILWAY and SIDING CONTRACTORS wishing to TENDER for the CONSTRUCTION of SIDING and EARTHWORKS at the above are requested to apply by letter only to Mr. T. WALLIS GORDON, City Engineer and Surveyor, Guildhall, Nottingham, enclosing a deposit of Two Pounds, which will be returned on receipt of a bona fide Tender.

The lowest or any Tender will not necessarily be accepted, and Tenders will only be considered from those firms having the necessary plant and experience.

W. J. BOARD, Town Clerk.

Guildhall, Nottingham, 20th January, 1923. 1324

East Indian Railway.

The Directors are prepared to receive up to Eleven o'clock a.m. on Wednesday, the 7th February, TENDERS for the SUPPLY of :—

LAMINATED SPRINGS.

Copies of the specification can be obtained at the Company's offices on payment of £1 1s. each. This fee will not be returned.

G. E. LILLIE, Secretary.

73-76, King William-street, London, E.C. 4. 24th January, 1923. 1374

Isle of Man Harbours.
TO DREDGING CONTRACTORS.

The Isle of Man Harbour Commissioners are prepared to receive TENDERS for certain DREDGING (about 15,700 cubic yards of marly clay and 3000 cubic yards of schistose rock), to be done at Douglas, Isle of Man.

Copies of the specification, form of Tender, and drawings may be obtained from W. H. Blaker, Esq., Assoc. M. Inst. C.E., the Engineer to the Commissioners, at the undermentioned address, on payment of £2 2s., which will be returned on receipt of a bona fide Tender.

Tenders, endorsed "Douglas Dredging," must be in the hands of the undermentioned not later than Monday, February 5th, 1923.

The Commissioners do not bind themselves to accept the lowest or any Tender.

By Order,
A. W. TONGUE, Secretary.

Isle of Man Harbour Commissioners' Offices, Douglas, Isle of Man, 16th January, 1923. 1298

Metropolitan Water Board.
TENDER FOR PIPE LAYING, REPAIRS, ALTERATIONS TO MAINS, &c.

The Metropolitan Water Board invite TENDERS for PIPE LAYING, REPAIRS, ALTERATIONS to MAINS, &c., within the areas of their Kent, Northern, Southern, and Western Districts, for the periods of six or twelve months from 1st April, 1923.

Tenders must be made on official forms, which may be obtained from the Chief Engineer, Metropolitan Water Board, New River Head, 173, Rosebery-avenue, E.C. 1, on and after Wednesday, 24th January, 1923, by personal application (Room 155), or upon forwarding a stamped addressed brief envelope. Applicants should refer to the number of the Tender (No. 17).

Tenders, enclosed in sealed envelopes, addressed to the "Clerk of the Board, Metropolitan Water Board, New River Head, 173, Rosebery-avenue, E.C. 1," endorsed "Tender for Pipe Laying," must be delivered at the offices of the Board not later than 11 a.m., Wednesday, 21st February, 1923.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER, Acting Clerk of the Board.

Offices of the Board, New River Head, 173, Rosebery-avenue, E.C. 1, 15th January, 1923. 1309

PUBLIC NOTICES

Bombay, Baroda, and Central INDIA RAILWAY COMPANY.

The Directors are prepared to receive up to Noon on Friday, 16th February, TENDERS for the SUPPLY of :—

LOCOMOTIVES AND TENDERS, 4-6-0.

Tenders must be made on forms, copies of which with specification, can be obtained at these offices on payment of 20s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG, Secretary.

Offices: 91, Petty France, Westminster, S.W. 1. 24th January, 1923. 1377

Madras and Southern Mahratta RAILWAY COMPANY, LTD.

The Directors are prepared to receive TENDERS for:
(1) 1676 HELICAL SPRINGS,
(2) 2094 DOZEN FILES,
in accordance with the specifications which may be seen at the offices of the Company. The charge for each specification is One Guinea, which will not be returned.

Tenders must be sent in, addressed to the SECRETARY, not later than 2 p.m. on Tuesday, 13th February, 1923, marked "Tender for Helical Springs" (or as the case may be).

The Directors do not bind themselves to accept the lowest or any Tender.

Company's Offices:
25, Buckingham Palace-road, Westminster, S.W. 1. 23rd January, 1923. 1349

Siam State Railways.
NOTICE.

Sealed TENDERS for the SUPPLY of 12,106·788 TONS of STEEL RAILS and PERMANENT WAY ACCESSORIES will be received by the undersigned at his office in the City of Bangkok, Siam, until Ten o'clock on the 16th April, 1923, at which place and hour the Tenders will be publicly opened and read.

Blank Tender forms, specifications and plans may be obtained from Messrs. C. F. Sandberg, 46, Grosvenor-gardens, London, S.W. 1, upon payment of £1 per set, which sum will not be refunded.

Right is reserved to reject any or all Tenders and to accept any Tender which, in the opinion of the undersigned, is to the best interests of the Siam State Railways.

PURACHATRA, Commissioner-General, Siam State Railways. Department of State Railways, Bangkok, 20th December, 1922. 1357

The Bengal and North-Western RAILWAY COMPANY, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of :—

1300 WAGON BUFFERS,
3500 VOLUTE SPRINGS,

as per specifications to be seen at the Company's offices.

Tenders, addressed to the undersigned, and marked "Tender for Buffers," or as the case may be, are to be lodged not later than Noon on Friday, the 16th day of February, 1923.

For each specification a fee of 10s. will be charged, which cannot under any circumstances be returned.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
E. A. NEVILLE, Managing Director.

4,237, Gresham House, Old Broad-street, London, E.C. 2, 18th January, 1923. 1318

The South Indian Railway Com- PANY, Limited, are prepared to receive TENDERS for the SUPPLY of :—

1. CAST IRON POT SLEEPERS.
2. SWITCHES and CROSSINGS.
3. FISH BOLTS, SPIKES, &c.
4. STEEL BEARING PLATES for F.B. RAILS.
5. STEEL FISH-PLATES (Special Patterns).
6. TIE BARS, GIBS and COTTERS.
7. AXLE-BOXES for CARRIAGES and WAGONS.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tenders for Cast Iron Pot Sleepers," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 9th February, 1923.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of £1 for each copy of Specifications Nos. 1 and 2, of 10s. for each copy of Specifications Nos. 3 and 4, and of 5s. for each copy of Specifications Nos. 5, 6, and 7.

Copies of the drawings may be obtained at the offices of Messrs. Robert White and Partners, Consulting Engineers to the Company, 9, Victoria-street, S.W. 1.

A. MUIRHEAD, Managing Director.

91, Petty France, S.W. 1, 23rd January, 1923. 1268

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PUBLIC NOTICES

County Borough of Halifax.

The Tramways and Electricity Committee of the Halifax Corporation are prepared to accept OFFERS for the PURCHASE of a 750 K.W. DIRECT-COUPLED BELLISS ENGINE and ELECTRIC CONSTRUCTION CO.'s DIRECT-CURRENT DYNAMO, 450 to 500 volts, together with a SURFACE CONDENSER.

Full particulars can be obtained on application to Mr. W. M. Rogerson, M. Inst. E.E., Borough Electrical Engineer, Electricity Department, 29, Northgate, Halifax.

The highest or any Tender will not necessarily be accepted.

Tenders to be delivered to the undersigned not later than Twelve Noon on Tuesday, February 6th, 1923.

By Order,
PERCY SAUNDERS,
Town Clerk

Town Hall, Halifax,
15th January 1923 1252

State Electricity Commission
OF VICTORIA.
TENDERS FOR PLANT.

TENDERS are hereby INVITED for the SUPPLY, DELIVERY, &c., of the following for the Morwell Power Scheme.

Copies of Tender form and specification may be obtained or inspected upon application to—
Agent-General for Victoria,
Melbourne-place, Strand,
London, W.C. 2.

SPECIFICATION No. 23/7.—MOTORS, STARTERS, and ISOLATING SWITCHES.

CHARGE.—£2 2s. for the first two copies of Tender form, conditions of contract and specification complete. This charge will be returned on receipt of a bona fide Tender. A third, or any further copies, will be supplied for the sum of 10s. 6d. each, not returnable.

PRELIMINARY DEPOSIT.—A preliminary deposit of £40 is required to be lodged with Tender.

The Commission does not bind itself to accept the lowest or any Tender.

Tenders on prescribed form, properly endorsed, and addressed, must be delivered to the undersigned in Melbourne, not later than Noon on March 15th, 1923.

R. LIDDELOW,
Secretary,
State Electricity Commission of Victoria,
1205 Melbourne, Australia.

State Electricity Commission
OF VICTORIA.
TENDERS FOR PLANT.

TENDERS are hereby INVITED for the SUPPLY, DELIVERY, &c., of the following PLANT for the Morwell Power Scheme.

Copies of Tender form and specification may be inspected or obtained upon application to—
The Agent-General for Victoria,
Melbourne-place, Strand,
London, W.C. 2.

SPECIFICATION No. 23/9.—TRANSFORMERS and SPARES.

CHARGE.—10s. for first two copies of Tender form, specification and contract conditions complete. This charge will be returned on receipt of a bona fide Tender.

A third, or any further copies, may be obtained on payment of 5s. per copy, not returnable.

PRELIMINARY DEPOSIT.—A preliminary deposit of £10 is required to be lodged with Tender.

The Commission does not bind itself to accept the lowest or any Tender.

Tenders on prescribed form, properly endorsed, and addressed, must be delivered to the undersigned in Melbourne, not later than Noon on April 28th, 1923.

R. LIDDELOW,
Secretary,
1206 State Electricity Commission of Victoria, Melbourne, Australia.

The London and North-Eastern
RAILWAY have FOR DISPOSAL the following ELECTRICAL MACHINERY and PLANT at their Doncaster Works :—

TWO 86 K.W. DIRECT-CURRENT DYNAMOS, by Thomas Parker, Ltd., 220 volts, 450 r.p.m., direct coupled to "Willans" COMPOUND ENGINES.
TWO 220 K.W. DIRECT-CURRENT DYNAMOS, by Greenwood and Batley, 220 volts, 350 r.p.m., direct coupled to "Willans" COMPOUND ENGINES.
ONE 220 K.W. DIRECT-CURRENT DYNAMO, by Bruce Peebles, 220 volts, 350 r.p.m., direct coupled to "Willans" COMPOUND ENGINE.
ONE SURFACE CONDENSING PLANT, by W. H. Allen, Son and Co., 35,000 lb. steam per hour, with "Edwards" AIR PUMPS and "Conqueror" CENTRIFUGAL CIRCULATING PUMP.
ONE 200 I.H.P., 55 r.p.m. "ROBEY" COMPOUND ENGINE, with Richardson and Rowland's patent cut-off gear, fly-wheel 15ft. diameter by 2ft. 6in. face, adapted for belt drive.
ONE BELT PULLEY, 10ft. diameter, by 2ft. 6in. face, for 7¼in. diameter shaft.
TWO LENGTHS BALATA BELTING, each about 80ft. by 2ft. 3in. wide.
TWO 30ft. by 8ft. LANCASHIRE BOILERS for working pressure of 130 lb. per square inch, with usual fittings and mountings.
ONE 28ft. by 8ft. LANCASHIRE BOILER, complete as above.
TWO "WEIR" BOILER FEED PUMPS, steam cylinder 8¼in. diameter, water cylinder 6in. diameter, stroke 15in., for feeding against 130 lb. pressure.

Tender forms, giving full particulars, can be had on application to Mr. W. F. WEEKS, Stores Superintendent, Great Northern Section, London and North-Eastern Railway, Doncaster.

Secretary's Office :
London and North-Eastern Railway
(Great Northern Section),
King's Cross Station, London, N. 1.
22nd January, 1923. 1330

Bedwellty Union.
APPOINTMENT OF RESIDENT ASSISTANT ENGINEER.

The Guardians of the Bedwellty Union invite APPLICATIONS for the APPOINTMENT of a RESIDENT ASSISTANT ENGINEER at the Union Workhouse, Tredegar.

Candidates must be single men or widowers without dependent children, and have had practical experience in Boilers, Steam Mains, Heating and Hot Water Service and Electrical Plant, and competent to perform the Plumbing and General Repair Work connected with a Poor Law Institution.

The person appointed will be required to work under the direction of the Master of the Workhouse and the Chief Engineer.

The ordinary working hours of the person appointed will be from 1 p.m. to 9 p.m., including Saturday, and Sunday duty will be performed alternatively with the Chief Engineer.

Salary £65 per annum, with lodging and washing and an allowance of 15s. per week in lieu of rations (this allowance is subject to revision), subject to the provisions of the Poor Law Officers' Superannuation Act, 1896. No uniform or overalls will be provided.

Applications, in candidates' own handwriting, with copies of three recent testimonials, on forms which may be obtained by forwarding me a stamped addressed foolscap envelope, must reach me not later than 10 a.m. on Wednesday, the 7th February, 1923.

By Order,
WILLIAM HALL,
Clerk to the Guardians.

Union Offices,
Tredegar, Mon.,
23rd January, 1923. 1362

Skegness Urban District
COUNCIL.

FIRST and SECOND ENGINEERS REQUIRED at the Sewage Pumping Station. Forms of application and particulars of duties obtainable from the undersigned, to be returned in time to reach me not later than Wednesday, 7th February, 1923. Canvassing will disqualify.

W. FREARSON,
Clerk.

Council Offices,
Roman Bank, Skegness,
23rd January, 1923. 1364

PUBLIC NOTICES

The Commissioners for the
PORT OF CALCUTTA.

APPLICATIONS are INVITED for ONE EXECUTIVE ENGINEER and for SIX ASSISTANT EXECUTIVE ENGINEERS with the following qualifications :

EXECUTIVE ENGINEER.—A Civil Engineer who is a Corporate Member of the Institution of Civil Engineers and who has had good experience on Dock Construction, preferably on a contractor's staff. Age about 33 years. Salary Rs. 1100 per month, rising by Rs. 50 to Rs. 1500 per month.

ASSISTANT EXECUTIVE ENGINEERS.—Civil Engineers who have had technical education in engineering, are physically fit and energetic, and who have had some experience on Dock Construction. Preference will be given to men who have passed the examination for Associate Member of the Institution of Civil Engineers or hold an exempting degree. They should be unmarried and age about 27 years. Salary Rs. 700 per month, rising by Rs. 50 to Rs. 1050 per month.

Applications, with copies of testimonials, to be sent to the undersigned not later than Monday, 29th January, 1923.

J. ANGUS, M. Inst. C.E.,
Consulting Engineer and London Agent.
10, Prince's-street,
Westminster, S.W. 1. 1266

24th January, 1923.

The Sudan Government Rail-
WAYS REQUIRE the SERVICES of a DISTRICT LOCOMOTIVE SUPERINTENDNET. Age 26/32, single. Candidates should have been trained on British railway or in a locomotive builders' works and should have good knowledge of the working of a locomotive department. A.M.I.C.E. degree desirable. Commencing salary £E480, rising to £E900 per annum eventually. Temporary war bonus. Strict medical examination.—Application, by letter, to CONSULTING MECHANICAL ENGINEER, Sudan Government Railways and Steamers, 5, Northumberland-avenue, W.C. 2. 1367

SITUATIONS OPEN

WANTED, a WORKS MANAGER, Familiar with Steam Engines, Condensing Plants and General Heavy Work ; must have had previous sound experience. Works employ about 400 hands normally and consist of pattern shops, smithy, foundry, machine, fitting, and erecting shops.—Address, giving age, previous experience, testimonials (copies only), and salary required, 1365, The Engineer Office. P365 A

WANTED by Old-established House of Engineers', Mill and Factory Furnishers, TRAVELLERS with experience and connection in counties of Berks, Bucks and Oxon and Essex, Suffolk and Norfolk. Liberal terms offered.—Write, with full particulars, Z. P, 610, care Deacon's, Leadenhall-street, E.C. 3. 1342 A

WANTED, First-class ENGINEER-SALESMAN as LONDON REPRESENTATIVE to British Firm of Manufacturers. Must be thoroughly conversant with the latest practice in internal combustion engineering. Good salary to right man. Must be keen, of good address, and able to get results. State experience, salary expected, and other particulars in strict confidence.
Address, P6774, The Engineer Office. P6774 A

WANTED in Midland District, a PRACTICAL ENGINEER. Must have some practical experience of Electrical Installation and Working. Applicants with a knowledge of the Steel Tube Trade will receive special attention. State salary required, experience, with copies of testimonials.—Address, 1372, The Engineer Office. 1372 A

WANTED, Smart REPRESENTATIVES with Good connection, to represent a progressive Foundry manufacturing high-class castings in aluminium, gunmetal, phosphor-bronze and brass. Only those able to influence big business will be considered. Commission basis.—Address, P6760, The Engineer Office. P6760 A

ASSISTANT REQUIRED for Publicity Department of Large Firm of Electrical and Mechanical Instrument Manufacturers. Previous experience in advertising and in catalogue preparation and technical engineering knowledge essential. State age, experience, and salary required.—Address, P6763, The Engineer Office. P6763 A

DESIGNING ENGINEER for Switchgear WANTED in London area. Applicants must have intimate knowledge of up-to-date designs. Sound practicality and technicality.—Address particulars of age, salary, and experience, 1276, The Engineer Office. 1276 A

ELECTRICAL ENGINEER WANTED, with Extensive experience in the Testing of Railway Traction Equipments and Control Gear or in the operation of same. Salary paid will be commensurate with experience.—Apply, with full particulars as to training and experience, to GENERAL WORKS MANAGER, The English Electric Company, Ltd., Queen's House, Kingsway, W.C. 2. 1336 A

ENGINEERING REPRESENTATIVE (30-35) REQUIRED by leading London Firm. Shops and D.O. training essential. State full details of experience and salary required.—Address, 1359, The Engineer Office. 1359 A

ENGINEER WANTED for the London District, well up in the Design and Construction of all types of Centrifugal Pumps. Must be able to handle inquiries and correspondence.—Address, giving full particulars and salary required, P6770, The Engineer Office. P6770 A

INDIA.—English FIRM of ENGINEERS and MERCHANTS in India REQUIRE an ENGINEER SALESMAN. Applicants should have had a training in Mechanical Engineering, be experienced in the Sale of Engineers' Tools, Machinery, &c., for which the firm hold agencies, and be accustomed to interviewing possible purchasers and obtaining orders, for which it will be necessary for him to travel when required. Must be a bachelor, age 25 to 28.—Address, giving full particulars of experience and qualifications, 1373, The Engineer Office. 1373 A

LIVE REPRESENTATIVE REQUIRED for Midlands by well-known Woodworking Machinery Manufacturers. Send fullest particulars, stating age, previous experience, salary and commission required.—Address, P6735, The Engineer Office. P6735 A

PRODUCTION ENGINEER WANTED for Motor Cycle Works of 300 men. Must have had good engineering training and be a first-class organiser, able to take responsibility for work coming through to time and for the general output.—Address, giving fullest details of past experience, age, and salary required, also how soon free, 1360, The Engineer Office. 1360 A

REPRESENTATIVE WANTED, to Solicit Orders and Inquiries from City Companies for Railway, Steamship, Mining and General Engineers' and Factory Stores. Exceptional terms offered to those with good connection.—Full particulars to Z. L. D., care Deacon's, Leadenhall-street, E.C. 3. 1341 A

REQUIRED, WATERWORKS TOWN SUPERINTENDENT. Must have experience of Distribution in all branches, Main Laying, Plumbing Work and Estimating for same. Some draughtsmanship and keeping of pipe plans. Good management of men essential. Population of town 60,000. Age from 30 to 35. Application in own handwriting with three recent testimonials. Salary £300 per annum.—Address, 1282, The Engineer Office. 1282 A

SITUATION VACANT for Qualified ASSISTANT MANAGER for large established Marine Oil Engine Works. State qualifications and general experience, age, and salary expected.—Address, 1338, The Engineer Office. 1338 A

STEAM TURBINE DESIGNER.—WANTED, ASSISTANT, thoroughly experienced theory and practice, Turbine and Compressor Design.—Write, giving details, experience, and salary required, Box 1271, Sells' Advertising Offices, Fleet-street, E.C. 4. 1350 A

SITUATIONS OPEN (continued)

TECHNICAL ASSISTANT to CHIEF ENGINEER REQUIRED, to carry out work in connection with Reconstruction of Iron and Steel Works. Applicants must have had large experience in modern electrically driven Iron and Steel Works, including modern Blast-furnaces, Plate Rolling Mills, &c., and be capable of dealing with general schemes, estimating and the specification of materials for ordering. State age, salary expected, and experience to SECRETARY, Consett Iron Company, Limited, Consett, Co. Durham. 1253 A

THE ENGLISH ELECTRIC CO., Ltd., Stafford, REQUIRES a TECHNICAL EXPERT for Starters and Regulators for A.C. and D.C. Motors. Applicants should give full particulars of their experience and salary required. 1322 A

THE SERVICES of MOTOR ENGINEER REQUIRED by prominent Firm in India, bachelor, age 25-35. Engineering training, thorough knowledge of Motor Cars and experi Salesman necessary. Previous Indian experience advantageous. Salary Rs. 700 per month, with prospects, passage out and home.—Reply, Box M.E. 326, c/o Dawson's Advtg. Service, 121, Cannon-street, London, E.C. 4. 1346 A

TRAFFIC INSPECTORS REQUIRED for Chinese Government Railways, to be fully qualified in all branches of traffic work, ten years' experience with first-class British railway essential, age not over 35, 3 years' agreement.—Applications, by letter only, with fully detailed summary of career and copies of testimonials, stating age and physical fitness, &c., to "D.C." c/o J. W. Vickers and Co., Ltd., 5, Nicholas-lane, E.C. 4. 1328 A

TRAVELLERS, with Connection Amongst Steam and Power Users, to Sell Plastic Packing and Jointing. Experience essential. Liberal commission.—Reply, "ALPHA 105," c/o Deacon's, Leadenhall-street, E.C. 3. 1354 A

VACANCY Occurs in London Patent Agent's Office for ARTICLED or PREMIUM PUPIL.—State particulars of education, age, &c., to Box 375, Pratt and Co., 51 and 52, Chancery-lane, W.C. P6746 A

WATER POWER.—WANTED, for Water Turbine Department of large Company in London, CHIEF ASSISTANT ENGINEER, experienced in Laying Out and Tendering for Water Power Installation ; general knowledge of Turbine Design advantageous. State age, salary, when free, previous experience, and attach copies of testimonials.—Write, Box 633, Advertising Offices, 84, Queen Victoria-street, London, E.C. 4. 1260 A

DRAUGHTSMAN - DESIGNER WANTED for Cold-starting Crude Oil Engines suitable for conversion to gas. Only thoroughly experienced men need apply.—Write full particulars, Box 1248, Sells' Advertising Offices, Fleet-street, E.C. 4. 1319 A

DRAUGHTSMAN, Experienced in Coal and Coke-handling Plant, for the Midlands. State full particulars of experience and salary required. Address, 1325, The Engineer Office. 1325 A

DRAUGHTSMAN (Jig and Tool) REQUIRED IMMEDIATELY, varied class of work. Only those with up-to-date tool-room experience need apply, stating age, experience, and salary required.—Address, 1317, The Engineer Office. 1317 A

DRAUGHTSMAN (Senior), Experienced in Marine Diesel Engine Details.—Address, stating experience and salary required, P6766, The Engineer Office. P6766 A

DRAUGHTSMAN, Thoroughly Familiar with the Stamped and Pressed Metal Ware Trades, including Lanterns and Signs ; accustomed to the Design of Apparatus and the Tools required for production. Applicants must have had wide technical and practical experience and be capable of adapting themselves to the numerous requirements involved.
Write, stating age, actual experience, and salary required, to BRITISH THOMSON-HOUSTON COMPANY, Ltd., Fittings Factory, Lower Hillmorton-road, Rugby. P6764 A

DRAUGHTSMEN.—WANTED, Experienced RAILWAY CARRIAGE and WAGON DRAUGHTSMEN.—Apply by letter, stating wages required, experience, &c., to the BIRMINGHAM RAILWAY CARRIAGE and WAGON CO., Ltd., Smethwick. 1370 A

ENGINEER'S DRAUGHTSMAN REQUIRED, Used to Involute and Bevel Gearing. State reference, salary, and age.—Address, 1376, The Engineer Office. 1376 A

EXPERIENCED DRAUGHTSMAN REQUIRED ; well up in modern design of Vertical Forced Lubrication Steam-driven Single and Two-stage Compressors.
Reply, with full particulars of career, theoretical and practical training, and salary required, REAVELL and COMPANY, Ltd., Ranelagh Works, Ipswich. 1352 A

GOOD ENGINEERING DRAUGHTSMAN WANTED for works in London area ; experience in Refrigeration essential, able to design and used to up-to-date drawing-office methods.—Write, stating age, experience, and salary required, Box 1249, Sells' Advertising Offices, Fleet-street, E.C. 4. 1320 A

REQUIRED, Westminster Office, Smart DRAUGHTSMAN (age 20 to 25). Only those having brains and initiative need apply.—Address, giving details, technical education, experience, age, &c., P6790, The Engineer Office. P6790 A

STRUCTURAL DRAUGHTSMAN.—WANTED for Manchester district, First-class DRAUGHTSMAN, able to design, make workshop details, and take out estimate quantities. Good opening for really first-class man.—Address, stating age, detailed experience, and salary required, 1278, The Engineer Office. 1278 A

WATER POWER DRAUGHTSMAN REQUIRED in London. Only those experienced in Water Turbines, both reaction and impulse, need apply. State full particulars of experience and salary required.—Address, 1357, The Engineer Office. 1357 A

FOREMAN WANTED, to Take Control of Machine Shops in medium-sized Engineering Works, Manchester district ; must have knowledge of General Engineering Work, Piecework, and Premium Bonus Systems. State age, experience, and salary.—Address, P6761, The Engineer Office. P6761 A

CORRESPONDENCE CLERK, with Knowledge of shorthand and typewriting, WANTED for Sales Department in Motor Cycle Works in provinces. While knowledge of Motor Cycle Work, and especially Export Trade desirable, not essential if applicant has energy and adaptability.—Address, giving fullest details of experience, age, and salary required, 1361, The Engineer Office. 1361 A

SITUATIONS WANTED

BUYER.—The MANAGER of a Large Engineering Works Purchasing Dept., who has an exceptionally wide knowledge of the markets of the country, DESIRES to NEGOTIATE NEW APPOINTMENT.—Write, Z. M., 613, c/o Deacon's, Leadenhall-street, E.C. 1243 B

CIVIL ENGINEER (24), B.Sc. (Eng.), 3½ Years' pract. exper., good surveyor and draughtsman, DESIRES SIT., waterworks, hydro-elec., or roads.—Address, P6722, The Engineer Office. P6722 B

CONSTRUCTIONAL ENGINEER.—CHIEF DESIGNER to a well-known firm DESIRES advancing POSITION offering good prospects. Wide experience of all classes of steel structures, including buildings under steel framed act. Replies in confidence.—Address, P6787, The Engineer Office. P6787 B

SITUATIONS WANTED (continued)

DESIGNER of AIRCRAFT. Over 12 Years' Experience of all types, patentee of valuable aerofoil, exceptional experience of flying boats, at present on research work, disengaged shortly, SEEKS APPOINTMENT as CHIEF DESIGNER with firm of standing needing ingenuity and originality.—Address, P6754, The Engineer Office. P6754 B

ENGINEER, A.M.I. Mech. E., Ex-Capt. R.E., Wide continental and foreign commercial and technical experience, DESIRES responsible POSITION, home or abroad. Experienced in marine engineering, waterworks, drainage, hydraulic work, electrical generating plant for power transmission, tramways and lighting, contractors' plant, light railways, dredging and excavating, steam and I.C. engines, workshop management, D.O. and surveying ; knowledge of Spanish and French, accustomed to control native labour, can stand tropical climate.—Address, P6755, The Engineer Office. P6755 B

ENGINEER CHIEF, All Depts. of Works Engineering, gas, elec., steam, hyd., &c., building construction, factory maintenance or production, draughtsman, at liberty in the near future, REQUIRES APPOINTMENT.—Address, P6778, The Engineer Office. P6778 B

ENGINEER, Dipl. M.E. (28), SEEKS POST as ASSISTANT with good firm. Experienced in general engineering, ropeways, conveyors, &c., shops and D.O.—Address, P6777, The Engineer Office. P6777 B

ENGINEER, Exceptional Experience in Heavy Oil and gas power, to TAKE CHARGE.—Address, P6781, The Engineer Office. P6781 B

ENGINEER REPRESENTATIVE, A.M.I. Mech. E., with practical and technical training, sound knowledge and experience of the French market in various branches, DESIRES to ENTER into COMMUNICATION with FIRMs desiring Representation, France, Belgium or other countries.—Address, P6768, The Engineer Office. P6768 B

ENGINEER REQUIRES BERTH. Educated Public and private schools, engineering school, university and railway shops. Experience : 2 years mercantile marine (chief engineer's certificate), 10 years in responsible loco. and traffic posts on leading British railway, 2 years managing director agricultural engineering firm, a year resident engineer on factory installations. During war was 3 years senior engineer of large naval base, including oil, petrol and steamships, road transport and civil engineering. Has managed a fleet of 180 commercial lorries and is accustomed to all colours of labour.
Address, P6748, The Engineer Office. P6748 B

ENGINEER, with Commercial and Works Experience, disengaged, SEEKS responsible POSITION ; 10 years as manager and assistant manager, non-ferrous metals, die casting, general engineering and ironfounding.—Address, P6755, The Engineer Office. P6755 B

ENGINEER (26). Sound Technical Training, D.O. experience, had control small manufacturing works 12 months, REQUIRES POSITION in Works or D.O. Accept small salary 6 months' probation.—Address, P6785, The Engineer Office. P6785 B

GENERAL MANAGER, with Many Years' Experience with large automatic machinery manufacturing firm, is OPEN for similar APPOINTMENT. Proved administrator and business developer ; highest qualifications.—Address, P6769, The Engineer Office. P6769 B

MECHANICAL and ELECTRICAL ENGINEER, sound technical education, works and drawing-office, thirteen years' engineering experience, including eight years as manager of estimating and buying department, specialised in steam generating plant and combustion, DESIRES similar APPOINTMENT.—Address, P6757, The Engineer Office. P6757 B

MECHANICAL ENGINEER, Having Many Years' commercial experience and knowing London markets, DESIRES POSITION SALES MANAGER, or would entertain London Agency.—Address, P6773, The Engineer Office. P6773 B

PUBLIC WORKS CONTRACTORS AND CONSTRUCTIONAL ENGINEERS.—A JUNIOR ASSISTANT (21), B.Sc., well up in outdoor and indoor work, OFFERS his SERVICES to FIRMS able to make use of and appreciate a hard, willing, and conscientious worker. No excessive salary asked or expected and a position in England preferred.—Please communicate, P6791, The Engineer Office. P6791 B

ROLL DESIGNER, of Proved Ability, with 5 Years' foreman's experience, DESIRES a CHANGE in similar capacity.—Inquiries should be addressed, P6749, The Engineer Office. P6749 B

TO FIRMS REQUIRING REPRESENTATIVE or WISHING to EXTEND PRESENT BUSINESS in INDIA and FAR EAST.—ENGINEER (32), accustomed responsibility and hard work, returning from India April, 1923, DESIRES NEGOTIATE ENGAGEMENT as Branch Manager or Assistant ; 15 years' experience manufacturing, maintenance, purchasing, sales, all classes engineering machinery and appliances, well educated, good address, capable taking charge sales or manufacturing side, well up shipping accounts, correspondence, publicity, highest references ; willing to travel.—Address, P6747, The Engineer Office. P6747 B

TRAINED ENGINEER, with Excellent Commercial and technical experience, young, active and with initiative, SEEKS POSITION as Sales Manager or Traveller. Highest references ; now at liberty.—Address, P6704, The Engineer Office. P6704 B

WORKS MANAGER, Excellent Long Service record with general engineers and ironfounders, SEEKS SIMILAR POSITION ; well-educated man, with sound works and D.O. experience, good organiser, successful control of labour ; moderate salary.—Address, P6656, The Engineer Office. P6656 B

A YOUTH of Good Education, Age 17, DESIRES to ENTER as a JUNIOR the DRAWING-OFFICE of an engineering or similar firm.—"S.," 21, Ilip-street, N.W. 8. P6751 B

ADVERTISER URGENTLY REQUIRES APPOINTMENT, Mech. Engineer and Draughtsman, with ability and initiative, Ex-Flying Officer (4 years), Honours B. Eng., G.I.M.E. (26), married. Apprenticed at well-known firm ; steam, gas, oil and petrol engines, refrigeration, hydraulics ; well versed in correspondence, good technical and commercial knowledge ; small salary, good prospects.—Address, P6788, The Engineer Office. P6788 B

ENGINEER and DRAUGHTSMAN, 15 Years Shops, 12 years drawing-office, London ; salary £5 weekly ; all-round experience, including experimental work, patents and general engineering.—Address, P6750, The Engineer Office. P6750 B

JUNIOR DRAUGHTSMAN and TRACER, Age 20, SEEKS SIT. as same or as J. Clerk ; 5½ years' D.O. experience.—BEESON, 8, York-road, Brentford, Middlesex. P6781 B

MECHANICAL DRAUGHTSMAN (27) SEEKS POST with General Engineering Firm, London district ; disabled ex-Service man. Interview solicited.—Address, P6780, The Engineer Office. P6780 B

MECHANICAL DRAUGHTSMAN, with Wide Experience in the design and lay-out of various industrial plants, power station design and general engineering, DESIRES SITUATION, London or South Coast.—Address, P6772, The Engineer Office. P6772 B

For continuation of Situations Wanted Advertisements see page 3.

Cobalt Steels for Permanent Magnets.

By J. FERDINAND KAYSER, Assoc. Met.

PART II.

WHILE the magnetic properties of the cobalt magnet steels soon attracted a great deal of attention, magnet users were at first inclined to view the commercial application of high coercive force steels as being more or less problematical and not likely to lead to either increased efficiency or, on account of their costly nature, increased economy.

MAGNETOS AND COBALT STEEL.

The pioneer movement to utilise the new steels was led by Mr. E. A. Watson, a director of the M. L. Magneto Syndicate, Limited, Coventry, who took up a very different attitude, and as soon as small quantities of the new steels first became available towards the end of 1919, he began to design new ignition apparatus. As the result of a great deal of intense application to the subject, the first ignition apparatus using cobalt steel magnets was ready to place on public exhibition at the Motor Car Show in 1920. The development of magnetos fitted with cobalt magnets has since been so rapid that at the recent Cycle Show over 30 per cent. of the magnetos exhibited were fitted with cobalt steel magnets, and 50 per cent. of the makers showing motor cycles were fitting such magnetos.

An inspection of the magnetos exhibited at last year's show at Olympia revealed the fact that cobalt steel was beginning to bring a powerful influence to bear upon the design of various pieces of apparatus which were being produced by British firms. This design was manifesting itself in two ways. First, in the modification of existing machines in which the horseshoe magnet previously employed was replaced either by a straight bar or bars, or by small magnets bent to a much shorter length than the old horseshoe. In some designs the straight bars were simply substituted for the original horseshoe, with as little modification as possible to the remainder of the machine, a typical construction of this nature being exemplified by Fig. 2. The alternative arrangement adopted by some manufacturers consisted in the use of two straight bars in parallel, one on either side of the armature and bridged at the two ends by a pair of pole pieces. These bars were mostly screwed to the pole pieces, but in one case were mortised into them—Fig. 3—so as to save the operation of drilling and tapping the magnets. Either type of construction enabled a very considerable saving in weight and dimensions to be made on the machine, and although the cost of the magnet may not have been materially reduced, the incidental saving in structural parts effected in consequence has no doubt resulted in a cheapening of the magneto as a whole. The reduction in dimensions is well illustrated by Fig. 8, showing two machines of identical electrical performance, one employing orthodox horseshoe tungsten steel magnets, and the other a pair of short magnets of cobalt steel.

A further direction in which important developments have been rendered possible by the use of cobalt steel is in connection with magnetos in which the magnet rotates while the coils are stationary. This construction, which offers many advantages from the mechanical and electrical points of view, has hitherto been extremely difficult of attainment, owing to the impossibility of making a tungsten steel magnet of sufficiently small dimensions, and at the same time of the requisite magnetic properties. The advent of cobalt steel has rendered this problem comparatively easy, and further developments in connection with revolving magnets may be looked for in the near future.

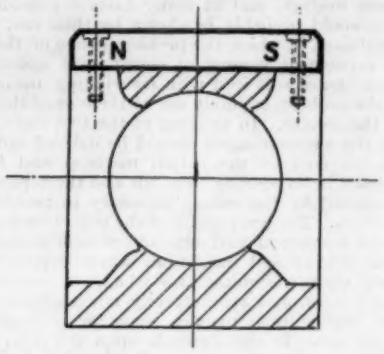


DIAGRAM SHOWING APPLICATION OF STRAIGHT BAR MAGNET TO MAGNETO TUNNEL

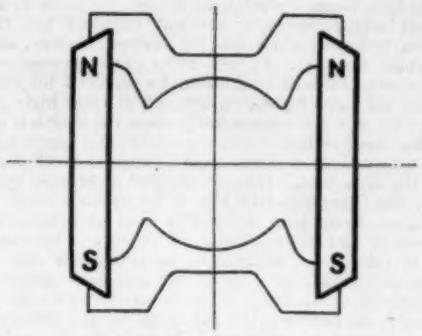


DIAGRAM SHOWING METHOD OF MORTICING STRAIGHT BAR MAGNETS INTO POLE SHOES

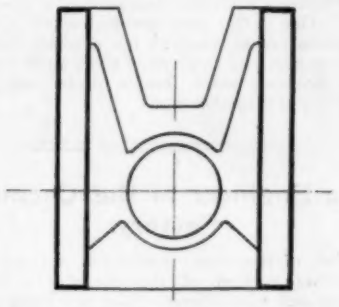


DIAGRAM SHOWING APPLICATION OF STRAIGHT BAR MAGNETS TO MEASURING INSTRUMENT

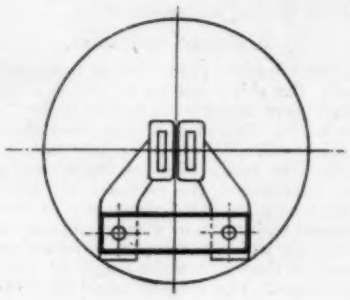


DIAGRAM OF TELEPHONE RECEIVER WITH STRAIGHT MAGNET

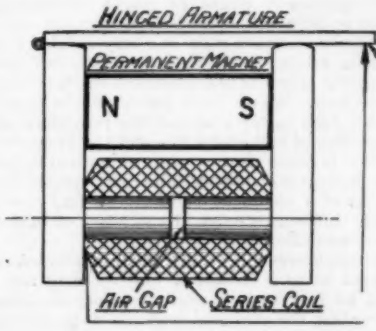


DIAGRAM ILLUSTRATING USE OF SHORT COBALT STEEL MAGNET FOR REVERSE CURRENT CUT-OUT.

"THE ENGINEER"

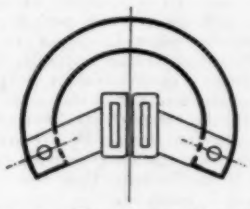


DIAGRAM OF TELEPHONE RECEIVER WITH BENT MAGNET

SMAIN &c.

FIGS. 2 TO 7—EXAMPLES OF THE APPLICATIONS OF COBALT STEEL MAGNETS

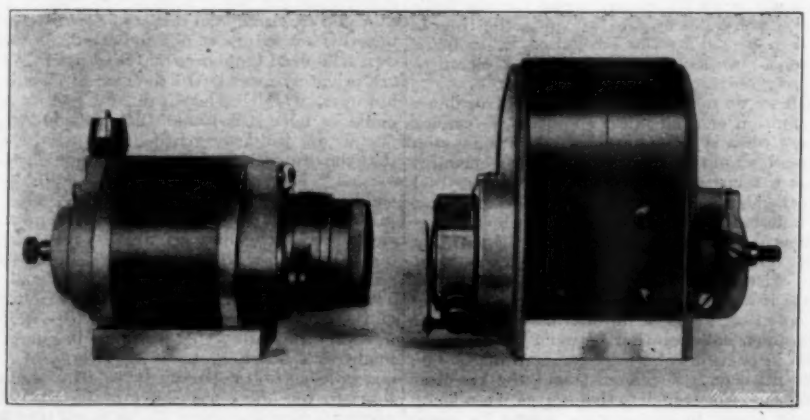


FIG. 8—A COMPARISON OF MAGNETOS

MOVING COIL INSTRUMENTS.

The advantages which are obtained by the use of cobalt steel for magneto magnets can also be obtained in most forms of moving coil instruments. In this case, however, there are one or two special requirements which may to a slight extent influence the shape of the magnet system, one requirement being that the centre of the suspension should be as nearly as possible at the bottom of the instrument case. This in general tends to favour a non-symmetrical arrangement of the pole shoes such as shown in Fig. 4, which indicates how a pair of straight magnets can be employed in place of the usual bent magnet.

Cobalt steel magneto magnets show a remarkable resistance to demagnetising influences due to electrical causes and also to vibration. In a measuring instrument, demagnetising forces due either to electrical conditions or shock are not usually present; but, on the other hand, it is very necessary that the magnets should maintain a constant flux for long periods of time. In this respect, tests show that if the usual precautions are taken, cobalt steel magnets are quite as permanent and lasting as tungsten steel magnets.

When a magnet is to be used in a measuring instrument, it should not be magnetised until at least seven days after hardening. It is then advisable to magnetise it fully and fit it to the pole shoes and leave the whole magnetic circuit for some weeks in order to give the flux time to settle down. After such a procedure, the magnets will prove quite permanent. Magneto magnets may be magnetised, and, in fact, it is desirable that they should be magnetised after the whole machine has been assembled; but such a procedure should not be followed in measuring instrument practice, unless after magnetising the magnets are electro-magnetically demagnetised to a slightly greater degree of demagnetisation than would be brought about by a removal of the magnets from the instrument.

Large numbers of magnets are used for their tractive force only. In certain signal apparatus, large horseshoe-shaped magnets are required to hold a movable component against gravity. Such magnets are very expensive to manufacture, as they are usually bent on edge with their poles brought very close together, and in that shape are quite permanent enough and will maintain their flux and traction effect for long periods of time. The cobalt steels, however, completely eliminate the need for such shaped magnets. A straight bar magnet made from a modern cobalt steel will, if suitably designed, lift from fifteen to twenty times its own weight.

It has long been known that tungsten steel bar magnets, unless thay are comparatively long and slender, maintain a surprisingly small flux, as in a bar magnet the poles are continually acting on one another, and exercising demagnetising forces on the parts of the magnet that lie between them. The

shorter the bar, the nearer together are its poles, and the greater is the demagnetising action they exert. A bar magnet, in which the length is, say, twenty-five times the width, will maintain approximately the same flux whether it be made from a good tungsten magnet steel with a coercive force of 65 to 70, or from a cobalt magnet steel with a coercive force of 200. Most instruments using straight unyoked bar magnets, however, must use, for various reasons, short stumpy magnets. In such cases tungsten steel magnets can, without hesitation, be replaced by cobalt steel magnets, which, on account of their high coercive force, work economically when the length is only some three or four times the width, and hence maintain a much greater flux than a tungsten steel magnet of the same size. This is very well illustrated by the cut-out exemplified in Fig. 5, in which a short bar magnet 3 cm. long is used to hold an armature in position and close an electric circuit. The magnet is in this design shunted by an iron-cored magnetic circuit comprising a small air gap and carrying a magnetising winding. Current in the one direction diverts the flux from the armature into the shunt path and releases the armature. That in the other direction increases the flux in the armature and holds it securely in place. A magnet of such a short length in tungsten steel would be quite useless, as under the action of the demagnetising effect of its own poles, combined with that of the current in the winding, it would soon become demagnetised.

Mariners' Compasses.

The oldest useful application of a magnet is undoubtedly the ship's compass. Former Admiralty compasses were fitted with needles over 7in. long, but the introduction of iron ships soon showed that such long needles, in whatever way they might be arranged, were badly adapted for several parts of compass adjustment, the necessity for which arose from the vastly increased deviations in steel ships, as compared with those in wooden ships, as the practical rules on which a compass adjuster works are based on the theory that the length of the compass needles is zero. The modern liquid-filled compasses are fitted with two tungsten steel magnets about $^{3}/_{16}$in. diameter and 3in. long, which is the longest length permissible. Such short magnets have, when made from tungsten steel, a considerable tendency to lose their strength and frequently lack pointing power. For cobalt steels the application is ideal, and several large vessels which have recently arrived home report so favourably concerning the behaviour of compasses using cobalt steel magnets, that numerous other vessels are having their magnet system converted. Generally, the mechanical damping of the liquid compasses is so complete that the increased moment of the magnets, when cobalt steel is used, does not shorten the period to any great extent, while the pointing power is very much increased. If, as sometimes happens, the period of the moving system is made too short on account of the increased magnetic moment of the cobalt magnets, as compared with the tungsten steel magnets, it is only necessary to shorten them. By so proceeding, the period can be made the same as with tungsten steel magnets, while at the same time the weight of the moving system is lessened.

Telephone Apparatus.

The demand for wireless telephone apparatus has acted as a great incentive to manufacturers of telephone watch receivers to improve their apparatus, and several have already adopted cobalt steel magnets. Various types of receivers are fitted with a straight bar magnet, as illustrated in Fig. 6. Such a design would be useless if tungsten steel magnets were used, but for a cobalt steel it is quite satisfactory. The magnets are quite simple and easy to manufacture, and fit into a standard-sized casing. Another type of magnet largely used in some design of receiver is illustrated in Fig. 7. The magnet is a little longer in this case than in the first case mentioned, and hence such receivers will act even when fitted with tungsten steel magnets. A magnet with a high coercive force maintains, however, a much greater flux than a magnet with a coercive force of 65–70, and the receivers fitted with cobalt steel can be tuned to give louder speech than those fitted with tungsten steel magnets.

Permanent *v.* Electro-magnets.

In view of the remarkable properties of cobalt steel as compared with tungsten and chromium alloys formerly employed, it becomes of interest to examine the problem of how far cobalt steel magnets may be expected to take the place of electro-magnets.

In general, the problem is a purely economic one—*i.e.*, Will the cobalt steel magnet cost any less than the electro-magnet it replaces?—but there are occasional instances in which the adoption of a permanent magnet would enable a considerable simplification to be made, which will introduce savings, apart from the magnet itself. As an instance, one could mention the small alternators which were used for wireless work on aeroplanes during the war. These alternators were revolving field machines, and as the revolving field had necessarily to be excited with direct current, they had to contain not only an alternator, but a small direct-current machine for use as an exciter. The use of a cobalt steel field magnet would have saved the cost of this exciter and very much simplified the whole machine.

Other instances could be mentioned in which accessory devices such as field regulators, &c., could be dispensed with should it be possible to use a permanent magnet, and in many cases a considerable saving could probably be shown by their use. In a general case, in which the problem is one of the cost of a permanent magnet of cobalt steel against the cost of one of soft iron with its winding, insulation, &c., the problem is purely one of the cost of the magnets themselves. In arriving at the two costs, however, the electro-magnet should be debited not only with the cost of the actual material and labour necessary in its construction, but also the capital cost represented by the energy necessary to provide the excitation. The comparison of the two cases involves a large number of variable factors such as the cost of the copper and insulation, which depends very greatly upon the voltage for which the magnet has to be wound, and are naturally much greater for a small high-voltage magnet than for a large low-voltage one. It also depends upon the cost of the current used for excitation, and upon the number of hours per annum during which this current is used.

It can be readily shown that the smaller the magnet the greater is the possibility of the permanent magnet being a successful competitor of the electro-magnet. One of the chief reasons for this is that the same excitation is required for a small magnet as for a large one, and the cost of the copper on a large magnet becomes much less in proportion than it does on one of a smaller size.

The Engineer in the Chemical Factory.

In view of the recent formation of the Chemical Engineering Section of the Society of Chemical Industry, and of the steps which are being actively taken to form an Institution of Chemical Engineers, no apology seems necessary on our part for saying a few words on the general topic of the engineer in the chemical factory. In saying this, however, it must be on the basis of not being misunderstood. This is no simple cut-and-dried matter, on which a general agreement exists or might reasonably be expected to exist, but at the present time, at any rate, it is a matter on which there is a very decided conflict of opinion, arising in the main from the difficulty in deciding the scope of the chemical engineer's duties in the factory. We all know the difficulties that have been met with in carrying out the provisions of the Safeguarding of Industries Act and the Protection of Dyes Act, because there was no recognised definition of fine or heavy chemicals, and with regard to the definition of a chemical engineer, we find that considerable differences exist in the ideas of individual chemical manufacturers.

Progress, however, is not entirely dependent upon agreement as to a definition, and we shall not need to wait for any such agreement before the schemes for according the chemical engineer a distinct status are firmly rooted. With regard to this status and the course of study by which it should be attained, it seems to us that we should keep in sight the fact of the existence of two main classes, the engineer employed in a chemical works and the engineer on the staff of an engineering works specialising in chemical plant. The common practice in the case of a small chemical works has been to have new plant installed by engineering firms which specialise in such plant, and to have the necessary upkeep and repairs carried out by the works engineer with or without the assistance of the works chemist. In such cases there does not seem to be any scope for the fully trained chemical engineer, and we think the time is distant when it will be the recognised thing for a small chemical works to appoint both a technical chemist and a chemical engineer.

Although we do not propose to tie ourselves down to any definition of a chemical engineer, we cannot well express what is in our mind without some step in this direction, and so we suggest that the chemical engineer is a man who is nine-tenths engineer and one-tenth chemist, and the technical or works chemist is a man nine-tenths chemist and one-tenth engineer. On this basis, it seems to us that by close collaboration the two would be able to design and erect new plant or modify existing plant to better effect than would be the case if a specially appointed works chemical engineer acted on his own initiative. There is not always as much collaboration between the different authorities in a chemical works as there might be; the works manager, the chemist and the engineer being apt to keep very much to themselves, a tendency to aloofness which, in our opinion, might be eradicated to the advantage of the works in which they are severally engaged. In our reference to the technical chemist, we are not thinking of the mere analyst, but rather of a man who has had a good training in physics, or, in other words, in the principles on which the art of the mechanical engineer is founded. As electricity enters so largely into both power plant and chemical operations in the modern chemical factory, it will be necessary for the engineer to be an electrical as well as a mechanical engineer, and, of course, the fully qualified chemical engineer, when he emerges from his course of university training, according to schemes now being promulgated, will have to be proficient in electrical engineering. This mention of university training leads us to the consideration of what is being done in other countries. In America it is certainly the case that more advance has to be recorded than with us, as several universities have established the degree of Ch.E., or chemical engineering. As a rule, the university courses are of five years' duration, including the time spent in works, and at Columbia University a post-graduate course of three years has been in operation since 1915, the total course of study thus extending over eight years. It is stated that all the university graduates easily find posts in chemical and allied factories at good starting salaries. With regard to Germany, we are not in a position to speak as to what part the universities have played or are preparing to play in turning out chemical engineers.

It is, however, common knowledge that the great progress made in the German chemical industry during the last twenty or thirty years has been due to the initiative, one might almost say genius, shown by her technical chemists in the design of new plant. Presumably, these chemists have specialised in engineering, or perhaps it would be more correct to style them engineers who by subsequent opportunities in chemical works have attained proficiency in chemical plant construction. We note that in the report of the British Chemical Mission to the factories in the occupied areas of Germany, the following passage occurs: "The engineers who play such a prominent part in the equipment of the Germany chemical works are trained in a manner similar in thoroughness and character to that of the chemist." With regard to this passage, it must not be assumed that it applies solely or even principally to the man stationed in the works. It certainly applies, though to what extent we do not care to hazard an opinion, to the chemical engineer we have referred to earlier on as being in a different category, the expert chemical engineer employed by the chemical plant manufacturer. These plant manufacturers may have several men in their employ, each an expert in some branch of manufacture, and they are always at the disposal of works contemplating the erection of new plant. We believe it to be the case that the free intercourse which exists between the buyer and seller of chemical plant in Germany and America has been decidedly advantageous to the chemical industries of those countries, and it is to the absence of such a fraternal spirit in British manufacturing circles that we must attribute the necessity that exists to go abroad for certain types of chemical plant. Our manufacturers seem to have the idea—and perhaps it is well founded—that if an outside engineering firm is entrusted with the manufacture of some special type of plant, it will try to sell the same type to competing firms. In America the case is different, the general idea being that the progress of an industry is arrested by trade secrets, and that it is best in the long run for all firms to be equally equipped with the most up-to-date plant.

Here we may appropriately recur to the American training of the chemical engineer, which, as we have said, takes place to a considerable extent in the chemical factory. This is feasible enough in America, where entry to the factory is easily obtained, but if our professors who are elaborating a similar scheme for chemical engineers in Britain think that they can follow suit, we fear that they will meet with disillusionment. The fact must be faced that chemical manufacturing is not on the same footing as coal or metal mining, in which the procedure is common property, and in which development depends almost entirely upon cash resources and good management. Certainly the mining schools of Freiburg and Clausthal in Germany and Selmeczbanya and Pribram in Czecho-Slovakia are situated at mines worked by Government, but this procedure is not universal, as witness our own schools at Camborne and Wigan, where the mines are privately owned. In the case of chemical works, however, whether there are any secrets worth the name or not, it is found that outside America the portals are jealously guarded, and we are convinced that the drawbridge will not be lowered at the "Open sesame" of the university professor, however loud the key in which it may be pitched. This difficulty in the way of students obtaining an insight into actual working practice may as well be recognised at the outset by those who are actively interesting themselves in the evolution of the chemical engineer. We are not unmindful, of course, of the axiom that difficulties exist to be overcome, and it is possible, though not very probable, that some of our largest works might lend a helping hand in the way of permitting access to certain departments and by issuing regulations to the effect that all information accidentally acquired regarding other departments is to be treated as strictly confidential. For the rest, it seems most improbable that small works would care to be bothered with students.

It seems to us, then, that in all probability the student's insight into large-scale operations will have to be gained at Corporation plant, such as gas, water and sewage works, to which access would be easily attained, and by multiplying those visits to chemical works which have always been a feature of the applied chemical courses at some of our universities. We may

seem to be unduly pessimistic about the possibilities of adequate training for the chemical engineer of the future, but to speak concisely—and we hope not too brutally—we do not think that the really capable man of the future will be the product of a university, any more than has been the case in the past. In our opinion, he will continue to be the product of his environment after he has left the university, though, of course, the scope and duration of time of his scientific studies cannot fail to affect profoundly his subsequent progress. *Nascitur non fit* will not apply here at all, the opportunity of acquiring knowledge and experience being absolutely essential. The works have been the school-room of the many prominent chemical engineers we possess to-day, and it will take a good deal to convince us that any of the schemes now in hand, having for their object the complete academic training of the chemical engineer, will come to effective fruition.

As we have allowed ourselves considerable latitude in discussing the engineer in the chemical factory, it may not be out of place to refer to the trade catalogues issued by the German chemical engineering firms. These catalogues are veritable mines of useful technical information, and are incomparably superior to the trade literature usually issued by British firms, which, as we have already said, are inclined to be reticent from fear of their competitors getting to know what they are doing. Perhaps, after all, this feeling of fear has no more foundation in fact than is the case with the mythical lions which beset the path of the timid in much of life's procedure, and we suggest that by following the German lead our plant manufacturers would be taking a course likely to redound not only to their own immediate advantage, but also to the ultimate advancement of our chemical industries. In view, however, of the different mentality of the British manufacturer and his principal competitors abroad, it would be unwise to expect any rapid change of plant, and it is, perhaps, not altogether beside the mark to suggest that all this pother about the evolution of the finished chemical engineer is somewhat premature, and that what is really wanted is the education of the employer. There are not wanting those who say that we already possess all the necessary means for the equipment of the chemical engineer, but that his efforts to make himself a living force in industry have been hampered by the Laodicean attitude of the employer. Granted that this lack of sympathetic co-operation exists, it certainly seems that at least as much attention should be paid to its removal as is now being directed to the less delicate problem of producing highly efficient *personnel* who may find their anticipated progress checked by formidable barriers of which they have had no previous warning.

BASED upon a system of definite specifications to be worked out by a sectional committee of the American Engineering Standards Committee, a recommendation was adopted at a meeting at Washington recently to make an investigation as to the uniform numbering of forging, casting, structural, tool and other steels. Opposition was expressed by makers of tool steel to the inclusion of this class of material in the investigation, but the resolution was carried. The conference was called by the Standards Committee at the request of the United States Bureau of Standards, and was attended by about thirty steel producers, consumers, representatives of technical societies and Government officials, including Dr. Burgess, head of the metallurgical division of the Bureau of Standards and chairman of the Metal Committee of the Federal Board of Specifications, who presided over the conference.

Twenty Years of Diesel Engine Building.*

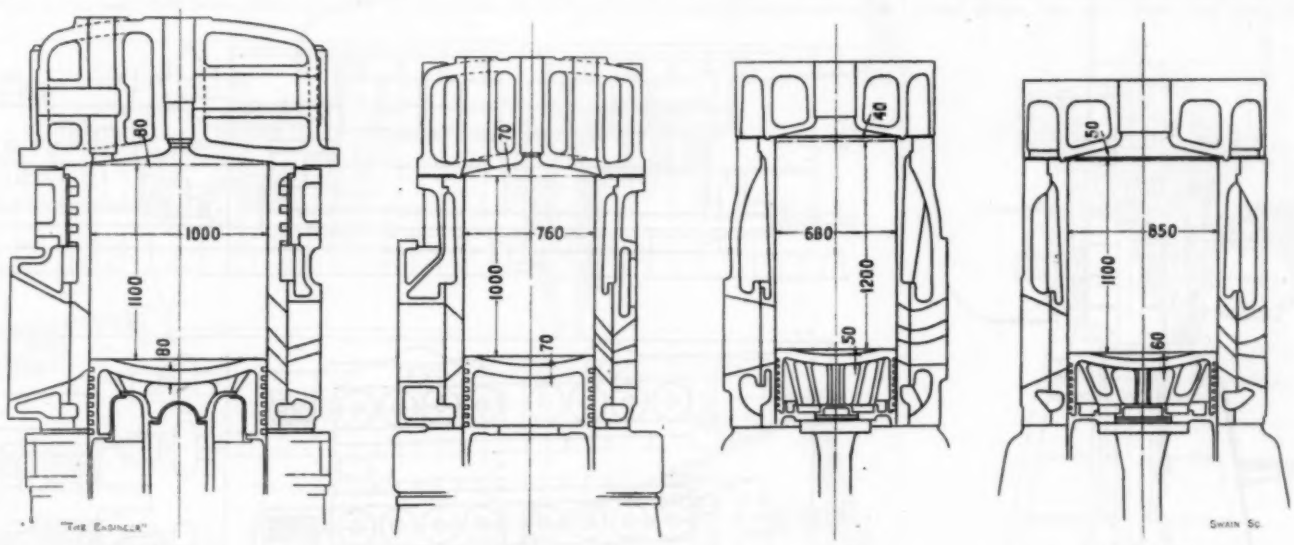
THE beginnings of the Diesel engine are comparatively fresh in the memory of most of us, scarcely twenty years having elapsed since the first commercial type of engine was manufactured. The story of the development of the Sulzer type of engine during this period was recounted in a paper read by Eng.-Lieut.-Commander L. J. Le Mesurier before the Institution of Engineers and Shipbuilders in Scotland on Tuesday last, the 16th inst. The paper opens with a description of the single-cylinder 30-40 brake horse-power unit first built in 1904, and closes with an account of a proposed scheme for a naval ship with four engines, each of 10,000 horse-power. We give a short synopsis of the paper.

Period 1893–1907.—Although Sulzer Bros. first acquired the Diesel patents in 1893, it was not until about 1903 that manufacture was undertaken on an important scale. The first engines were of the four-stroke cycle type with the well-known A design of column. The two-stage air compressor was operated by a lever from the connecting-rod, and compressor intercoolers were introduced at an early date. The torsion spindle type of fuel valve was used. Between 1903 and 1907 approximately seventy engines of this type were built, ranging in power from single-cylinder engines of 25 brake horse-power up to three-cylinder engines of 750 brake horse-power. Even at this period fuel consumptions of the order of 0.416 lb. to 0.417 lb. per brake horse-power hour were attained, with a mechanical efficiency of from 75 to 77 per cent. Early in 1904 a marine installation was built, comprising a 50 brake horse-power engine and a magnetic clutch. The arrangement, though expensive and somewhat complicated, worked well and aroused interest in the application of the Diesel engine to the wider field of marine engineering. During this period experiments were continually made with the object of evolving a two-cycle type of engine which would be lighter in weight and simpler from the point of view of the reversible marine engine. The first engine of this type was constructed in 1905. It was a four-cylinder engine of the high-speed enclosed type, developing 100 brake horse-power at 400 revolutions per minute. Valve scavenging was employed, and in the later forms of design the scavenging pumps and air compressors were driven by a separate crank. As in the case of the modern engines, the thrust block was incorporated in the bed-plate.

Period 1907–1910.—These years were noted for the development in large two-stroke cycle stationary engines for electric generating stations. Valve scavenging continued to be employed, four valves per cylinder being used. The main design of the columns remained unaltered, but the cylinder cover was complicated by the addition of the four scavenging valves. Load on the gudgeon pin calculated on a maximum pressure of 500 lb. per square inch with a pin of 170 mm. diameter, with a total length of 260 mm., worked out at 2200 lb. per square inch on the projected area. No difficulties have been experienced with these bearings, although the loading would be considered extremely high in steam engine practice. In general, the fuel consumption of these engines was considerably higher than that of similar four-stroke engines, largely owing to the high scavenging pressures—5 lb. to 6 lb. per square inch—which were used. Although at this time the results did not justify a strong policy in favour of the two-stroke cycle engine, the possibility and direction of improvements was clearly indicated.

Period 1910–1915.—A new design with port scavenging eventually led to the permanent adoption of a modified form of port scavenging patented in 1910, which is now recognised as the outstanding distinctive feature of the Sulzer type of engine. The Monte-Penedo, equipped with twin four-cylinder engines of this type, was put into service late in 1912. This vessel, now known as the Sabara, has had a chequered career. Up to the August, 1914, she had run 65,000 miles, the only important defect arising from piston heat cracks. The original design of piston has been replaced and no further trouble has been experienced from this cause. The Sabara was interned during the war in Brazil, and was laid up at Messina from 1920 to 1922 owing to legal charter difficulties. The vessel did a further 50,000 miles from the end of the war until the end of 1920. A crank shaft has been replaced, the original design was, it is to be noted, 20 per cent. weaker than Lloyd's standard. The ship is again in Brazilian service.

The 2000 Brake Horse-power Single-cylinder Experimental Engine.—In order to arrive at a definite idea as to the limits of output obtainable in a single cylinder, early in 1914 an experimental engine was built with a cylinder of 1000 mm. bore by 1100 mm. stroke. Exhaustive experiments on scavenging with upper and lower ports were carried out, the trials of this engine being supervised by Dr. H. Stodola. The cylinder head is shown in section in the left-hand view of the drawing reproduced in Fig. 1. It rests on four columns of forged steel, and the cylinder is suspended from the head in such a way as to be capable of expanding freely downwards. Heavy cast iron columns secure transverse rigidity and carry the four slipper guides of the symmetrical crosshead. All working loads are taken by the steel columns, thus relieving the cast iron framing from tensional stresses. Considering that the total working pressure on a piston of these dimensions amounts to over 300 tons, the problem of designing both framework and running parts, particularly the gudgeon pin bearings, was a formidable one. The records of the trials made with the upper row of scavenging ports blanked off and the lower ports only used for scavenging air showed that there was a considerable loss in output and efficiency when scavenging takes place through the lower ports only, and confirmed many other similar experiments with smaller engines as to the advantages of having an upper row of scavenging ports controlled by a valve. The most important effect of these tests was, however, to inspire confidence in the possibility of dealing with the heat stresses and designing satisfactory mechanical arrangements of engines of any power that might reasonably be required either for marine or stationary installations.



1912.		1915.		1922.		1922 (design).	
B.H.P. per cylinder	2000	B.H.P. per cylinder	750	B.H.P. per cylinder	500	B.H.P. per cylinder	1250
Revolutions per minute ..	150	Revolutions per minute ..	132	Revolutions per minute ..	100	Revolutions per minute ..	170

FIG. 1—COMPARISON OF EXISTING CYLINDERS WITH THAT OF PROPOSED 10,000-B.H.P. ENGINE

At the beginning of 1915 two large marine four-cylinder engines of 1600 brake horse-power, along with auxiliaries, were tested by Dr. Stodola. The war prevented these engines from being installed in their ship, but the test bed results show that even ten years ago there was no difficulty in dealing with the essential problems of a marine Diesel engine developing on overload 500 brake horse-power, or 750 indicated horse-power per cylinder. The dimensions of these engines were as follows:—Four cylinders, each 680 mm. bore by 960 mm. stroke, designed to develop 1600 brake horse-power at a speed of 110 revolutions per minute. The fuel consumption of 0.479 lb. per brake horse-power hour with a scavenge air pressure of 3.1 lb. per square inch is higher than with present-day engines, owing chiefly to the improved scavenging. The engines for the Camranh have the same diameter of cylinders, but with scavenging blowers, and the test results last year gave a figure of 0.411 lb. per brake horse-power for the fuel consumption with a scavenging air pressure of 1.5 lb. per square inch.

Stationary Engines and Small Engines, 1915–1922.—Although engines of the four-stroke cycle type continued to be built in sizes up to 1000 brake horse-power, all engines above this power were exclusively of the two-stroke cycle type, and considerable progress was made in standardisation of details and a reduction in the cost of manufacture. The experience gained in the construction of large power units of this type up to 1915 may be gauged by the fact that up to this date twenty-four engines, representing a total of 27,400 brake horse-power, were supplied. These were three and four-cylinder engines in units from 750 to 2000 brake horse-power.

A six-cylinder unit developing 4000 brake horse-power was built in 1915. The cylinder dimensions were 760 mm. bore by 1020 mm. stroke, and the power was developed at a speed of 132 revolutions per minute. A general outline of the cylinder arrangement is reproduced in Fig. 1. Some progress was made with the automatic control of the injection air to meet variations in the electrical load, a special governing device being employed. Although many of these large engines were employed in generating stations,

* Extracts from a paper read before the Institution of Engineers and Shipbuilders in Scotland by Eng.-Lieut.-Commander L. J. Le Mesurier.

a study of the design and working of such engines will well repay the marine engineer.

Marine engineers are inclined to regard the conditions of service in a stationary plant as much less arduous and exacting than those which obtain in a marine installation. While it must certainly be recognised that the Diesel engine has to be designed to meet the special conditions arising in each case, it is by no means to be taken for granted that the marine conditions are more difficult to fulfil. The stationary plant coupled to a generator has, for instance, to maintain a uniform speed under widely varying conditions of load, and, apart from the difficulty in providing an efficient governing arrangement, the engine does not settle down to a favourable steady condition of temperature such as is obtained during the prolonged running usual with a marine engine. Turning to the smaller engines, until a few years ago it was Sulzer practice to make all small stationary engines and marine auxiliary engines of the ordinary four-cycle Diesel type with air injection. The latest (RV) type of engine for such purposes is a two-cycle engine with airless injection and crank case scavenging, in which latter feature the engine bears a resemblance to the well-known semi-Diesel or hot-bulb engine. The compression pressure is about 450 lb. per square inch, and is sufficient to cause ignition as in an ordinary Diesel engine; there is thus no necessity for a hot bulb, and the fuel consumption is approximately the same as would be obtained by a Diesel engine with air injection. Compressed air stored at a pressure of 300 lb. to 100 lb. per square inch is used for starting purposes, and is supplied by a small two-stage compressor, which may be either coupled to the engine or hand operated.

For locomotive work the same system of fuel injection is used, but the engine, being of the V type, does not lend itself readily to crank case scavenging, and the four-stroke cycle is chosen. A further advantage of the four-cycle type is that the temperature of the exhaust being much higher than in a two-cycle engine, the exhaust gases are available for heating purposes.

A full description of a Diesel electric rail car fitted with a Sulzer engine of 200 to 250 brake horse-power was published in THE ENGINEER on December 29th, 1922.

Marine Engines, 1915–1922.—The war greatly handicapped the manufacture of marine engines for merchant vessels, but during this period many engines were built for gunboats, naval patrol vessels, tugs, &c., of a design applicable to merchant vessels, totalling in all over 45,000 brake horse-power. In addition, about sixty submarine engines were built, the aggregate power being about 50,000 brake horse-power; the largest unit was an eight-cylinder engine of 3500 brake horse-power running at 300 revolutions per minute. All these engines were of the two-cycle type with controlled port scavenging. In the earlier engines the valve controlling the upper port was of the double-beat type, operated by cams in a similar manner to the valves shown in the stationary engines, but later a simplification was effected by using a rotary valve which revolves at half the crank shaft speed. A section of this valve is shown in the drawing reproduced in Fig. 2. A further simplification was the introduction of a new form of cylinder cover, illustrated in Figs. 1 and 2, having one central opening, and all necessary valves, including the fuel valve, air starting valve and decompressfon valve, grouped in the one centrally placed valve casing. Improvements in reversing gear and the controlling servo-motors were also made. For the larger powers turbo-blowers were introduced, resulting in saving in weight and space, especially important in submarine construction. In cases where steam auxiliaries are employed steam turbine-driven blowers may be used instead of blowers driven by high-speed electric motors. The twin-screw motor ship Handicap, with a machinery installation of 2700 shaft horse-power, is fitted with turbo-blower, electrically driven and running at a speed of about 2700 revolutions per minute. The results so far obtained from this ship have been entirely satisfactory, the vessel having covered approximately 49,000 sea miles from December, 1921, to January, 1923.

Other examples of the present-day design of marine engine are the engines installed in the Conde de Churruca and the machinery which has recently been completed for the motor ship Camranh. In the case of the latter ship the arrangement of main engines will be similar to that adopted on the Handicap, but the cylinder dimensions are larger.

Large Marine Engines.—The motor passenger liner of 13,000 brake horse-power now under construction at the Fairfield yards represents a notable advance in the progress of the motor ship. Being a four-shaft ship, the engines themselves are of comparatively moderate power, and all the essential problems have long since been dealt with and solved satisfactorily. It is perhaps interesting to speculate upon the maximum power per unit that may be obtained without taking either undue risks or departing from the general design of single-acting two-cycle Sulzer engines already described. As the machinery installations of all merchant vessels, with the exception of fast passenger liners, will certainly fall within this maximum, it is proposed to examine a project for a naval vessel having four shafts and developing 40,000 brake horse-power with eight-cylinder engines running at 170 revolutions per minute. The proposed machinery would be as follows:—

	Main engines.	Auxiliary engines.
Number of engines	4	4
Number of cylinders per engine	8	4
Diameter of cylinder, mm.	850	470
Stroke of cylinder, mm.	1,100	600
Brake horse-power per engine	10,000	1000
Indicated horse-power per engine	12,600	1430
Revolutions per minute	170	240
Piston speed in feet per minute	1,230	945
Indicated mean pressure, pounds per square inch	94.5	92

The turbo-blowers and cooling water pumps are electrically driven and absorb per main engine approximately 700 brake horse-power, supplied by the auxiliary engines.

The total weight of the main and auxiliary engines, turbo-blowers and pumps with their motors, air reservoirs, compressors, silencers, &c., amounts to about 2750 tons. The weight is thus 150 lb. per brake horse-power, which compares with about 70 lb. per brake horse-power for submarines, and 290 lb. per brake horse-power for ordinary cargo vessels fitted with Sulzer two-cycle main and auxiliary engines.

The following table shows a comparison with the proposed design embodying the following engines:—

Type.	Stationary.	Submarine.	Cargo vessel.	Proposed engine.
Weight of one main engine in tons	344	74.5	204	525
Weight of one corresponding auxiliary engine without dynamo	—	16	17	67
Brake horse-power (total)	4,500	3,500	2,000	10,000
Brake horse-power per cylinder	750	435	500	1,250
Revolutions per minute	132	300	100	170
Cylinder diameter, mm.	760	540	680	850
Cylinder diameter, inches	30.4	21.3	26.8	33.5
Cylinder stroke, mm.	1,020	570	1,200	1,100
Cylinder stroke, inches	40	22.4	46.5	43.4
Piston speed, feet per minute	885	1,120	790	1,230
Indicated mean pressure in lb. per square inch	94	100	93	94.5
Weight of engine in tons per cubic foot of stroke volume	3.42	2.02	3.30	2.98

(1) Stationary engine of 4000 brake horse-power with six cylinders, completed in 1915, having direct-driven scavenging pumps. With separate electrically driven scavenging blowers the power would be 4500 brake horse-power when working with the same indicated mean pressure, and for purposes of comparison this power has been assumed.

(2) Submarine engine of 3500 brake horse-power having eight cylinders, with separate electrically driven scavenging blowers. This engine developed 3745 brake horse-power while on trial in 1920.

(3) Standard marine engine of 2000 brake horse-power, having four cylinders and separate electrically driven scavenging blower.

Piston Speed.—In accordance with the usual practice for naval machinery, the piston speed is higher than in other examples of actual engines, but this does not present any difficulty as regards scavenging and charging the cylinder, while as regards the mechanical arrangements, due consideration is given to reducing the reciprocating and rotating masses by using material of greater tensile strength. In submarine engines built by the M.A.N. Company piston speeds as high as 1470ft. per minute have been successfully realised in practice.

Mean Pressure.—A very moderate indicated mean pressure of only 94.5 lb. per square inch has been chosen, which should allow for a good margin of overload. The 1250 brake horse-power engines in the Conde de Churruca have worked continuously for long periods at indicated mean pressures of about 117 lb. per square inch without any visible signs of overload and with a clear exhaust.

Fig. 1 shows a comparison between the proposed design of cylinder and some designs of cylinders already constructed. Progress has been in the direction of simplifying the castings of liners, cylinder covers, and pistons, and in providing large cooling water spaces free from any obstruction. It has also been found possible, owing to improvements in design, to lessen the thickness of material in the above-mentioned parts, thereby reducing stresses due to the temperature difference between their inner and outer surfaces. On the whole the thermal conditions in the proposed design are therefore more favourable than in either the experimental 2000 horse-power single-cylinder engine or the 4000 horse-power engine, which has been in service for about six years.

The weight of the proposed engine per cubic foot of cylinder volume lies between the weight of a stationary engine and submarine engine measured on the same basis. The submarine engine, owing to limited head room, requires a much smaller stroke-bore ratio, namely, 1.05, whereas the proposed design allows of a ratio of 1.3, which is more favourable, as it increases the mechanical efficiency from about 68 to 74 per cent.

In calculating the efficiency the power for driving the scavenging pumps is deducted from the total brake horse-power of the engine. Thus the efficiency of the proposed engine is 10,000 minus 700 divided by 12,600, or 74 per cent.

Taking into account the comparatively light moving masses, the total weight allows of sufficient material being put into the bed-plate, framing, and cylinders to ensure adequate rigidity of the whole structure.

Fig. 2 shows a section through the engine which does not differ in any essential feature from the standard type of Sulzer marine engine, while Fig. 3 shows a general arrangement of the machinery with four shafts in a ship of 77ft. beam, the total length of the machinery space being about 136ft.

Among the advantages that may be mentioned for a naval vessel equipped with Diesel instead of steam machinery are:—

(1) Increased radius of action on a given supply of fuel. In the proposal described the consumption of fuel at full power would not exceed 185 tons per day, or less than half

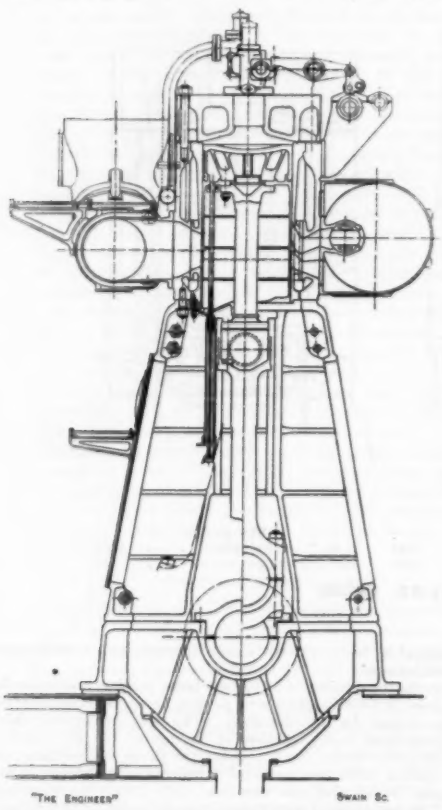


FIG. 2—SECTION THROUGH 10,000-B.H.P. ENGINE

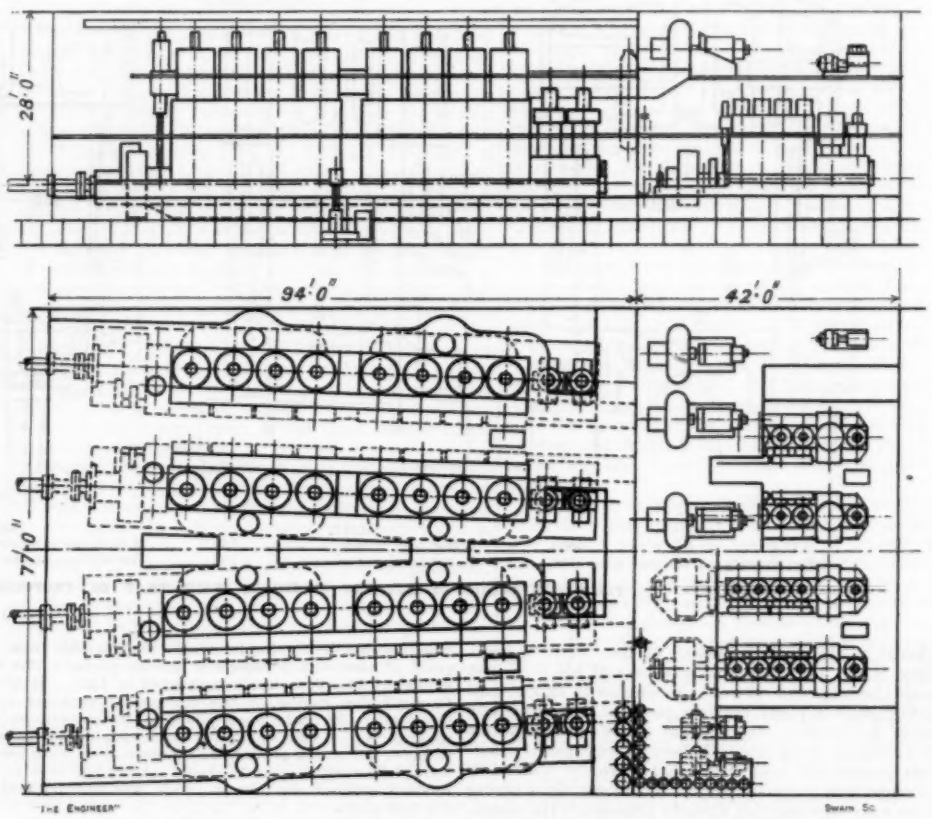


FIG. 3—MACHINERY ARRANGEMENT FOR PROPOSED 40,000-B.H.P. NAVAL VESSEL

the weight required for a steam vessel of the same power.

(2) The ability to proceed to sea at short notice or to increase rapidly from cruising to full speed.

(3) Absence of uptakes and funnels, with consequent advantages in the disposition of armament and in less vulnerability to attack from above, owing to the reduced area of openings in the armour deck. In an aircraft carrier a perfectly free landing deck can be easily provided.

(4) Risk of being put out of action by damage to steam pipes or boilers entirely eliminated.

These advantages would appear sufficiently important to induce naval constructors to study the possibilities of high-powered Diesel engines, the employment of which in naval craft would doubtless lead to results not less far reaching than may be confidently expected from the 13,000 brake horse-power passenger liner now under construction by the Fairfield Shipbuilding and Engineering Company, Limited.

Institution of Mechanical Engineers.

INDICATORS.

THE Institution of Mechanical Engineers met at Storey's-gate on Friday, the 19th inst., to discuss a symposium of papers on "Indicators," but in the outcome very little actual discussion took place, as the presentation of the papers themselves, together with the business in preparation for the annual meeting, occupied practically the whole of the evening, and so engrossed the attention of those present, while everyone was so anxious for an opportunity for inspecting the exhibits in front of the lecture table, that it was decided to adjourn the meeting to Friday, February 9th.

Dr. Hele Shaw, the President, took the chair, and first announced that Professor Coker had generously returned to the Institution the whole of the expenses involved by his Paris lecture on the action of cutting tools, in which he showed the stresses produced in the tool and work by means of polarised light. Professor Coker had suggested that the money might be used to found a research prize fund in memory of George Stephenson. Some members of Council had added to the fund to such an extent that it already amounted to £500. Further subscriptions would be welcome.

It was very apparent, when the secretary had read out the names of the proposed President and Council for the ensuing session, and the members were given an opportunity for nominating others to the list, that the new by-laws affecting the constitution of the Council have stimulated the interest of the members in the affairs of the Council. Several members proposed names for addition to the list, and their nominations were readily seconded, so that ultimately four more, mostly from the provincial branches, were included in the ballot list.

In calling on the authors to present their papers, Dr. Hele Shaw remarked that the subject was most appropriate, as the Institution was about to conduct an extensive test of marine oil engines, in which indicators would naturally be used very largely. The papers comprised:—"The Problems of the Engine Indicator," by Loughnan Pendred; "A New Form of Optical Indicator," by Professor F. W. Burstall; "Micro-Indicator for High-Speed Engines," by W. G. Collins; and "R.A.E. Electrical Indicator for High-Speed Internal Combustion Engines and Gauge for Maximum Pressures," by H. Wood.

Of the four short papers, that presented by Mr. Pendred was devoted to a general review of the problems of the engine indicator. Having recalled the work of Osborne Reynolds, who nearly forty years ago first called attention to the fallibilities of the indicator, he proceeded to review the effect of inertia, spring vibration, piston friction, and other influences which tend to destroy the accuracy of its readings. Thereafter he passed in review certain important features in the design of indicators. The paper ended with some general notes on the design of optical indicators. The conclusions arrived at were that Osborne Reynolds probably exaggerated the inaccuracy of indicator cards, but that even to-day the possibility of an error of ±5 per cent. should be admitted for all indicators on engines running at or over 300 revolutions. The assumption, expressed in some text books, that the various errors tended to neutralise one another put scientific measurement on a low plane, and was not wholly justified by the facts.

The paper by Professor Burstall was devoted exclusively to the detailed description of a new optical indicator designed by the author primarily for research work on medium speed, high-compression gas engines. The indicator is of the piston type, and in its design the author followed four guiding principles, viz.:—(1) All the fits should be of a geometric type, so that their accuracy would be independent of the workmanship; (2) the indicator should be water cooled; (3) the piston should be lubricated without requiring its removal from the cylinder; and (4) the camera body and all other parts should be metallic in order to avoid light leakage by the splitting of wood in exposed positions. A general view of the indicator is given in Fig. 1. The spring—Fig. 2—is made in one piece of tool steel, and in the working portion is tapered to give it uniform strength. It is fixed *encastre* at one end, and towards the other is attached to the top of the piston-rod by a ball and socket connection—Fig. 4. A setting plug—Fig. 3—is used to ensure that the ball on the spring is exactly central with the cylinder before the spring is finally bolted in position. The piston is slightly barrelled to prevent its sticking in the cylinder as a result of the slight curvature of the path of the ball joint. It has an area of 0.125 square inch, so that at the maximum pressure of 600 lb. per square inch, for which the indicator was designed, the total load on it is 75 lb. The total movement of the piston is about 0.08in. The cock body and plug—Fig. 6—are water cooled. At its upper end the cock body is formed for the reception of the piston, and has attached to it a hand-operated lubricator—Fig. 7—from which oil is admitted through three fine holes drilled at an angle to the cylinder and piston. The source of light is a "Pointolite" lamp, in which the illumination is secured by means of an incandescent metallic ball. The light is transmitted through a diaphragm on to a mirror mounted at the end of the indicator spring, and thence on to a second mirror oscillated by means of a quadrant arm connected through a wire and lever rig with the engine piston. The ray is then transmitted on to a photographic plate, an optically-worked glass screen being interposed in front of the plate to prevent damage being caused by the splashing of oil against the sensitive surface. The diaphragm referred to—Fig. 5—confines the light to a single pencil. It was found difficult to drill a hole having regular edges if the diameter were less than 0.002. The diaphragm opening is, therefore, formed by means of two pairs of steel plates with polished edges, one pair being fixed above the other and at right angles to it.

The two remaining papers, one by Mr. Collins, the other by Mr. Wood, are reprinted more or less in full elsewhere in this issue.

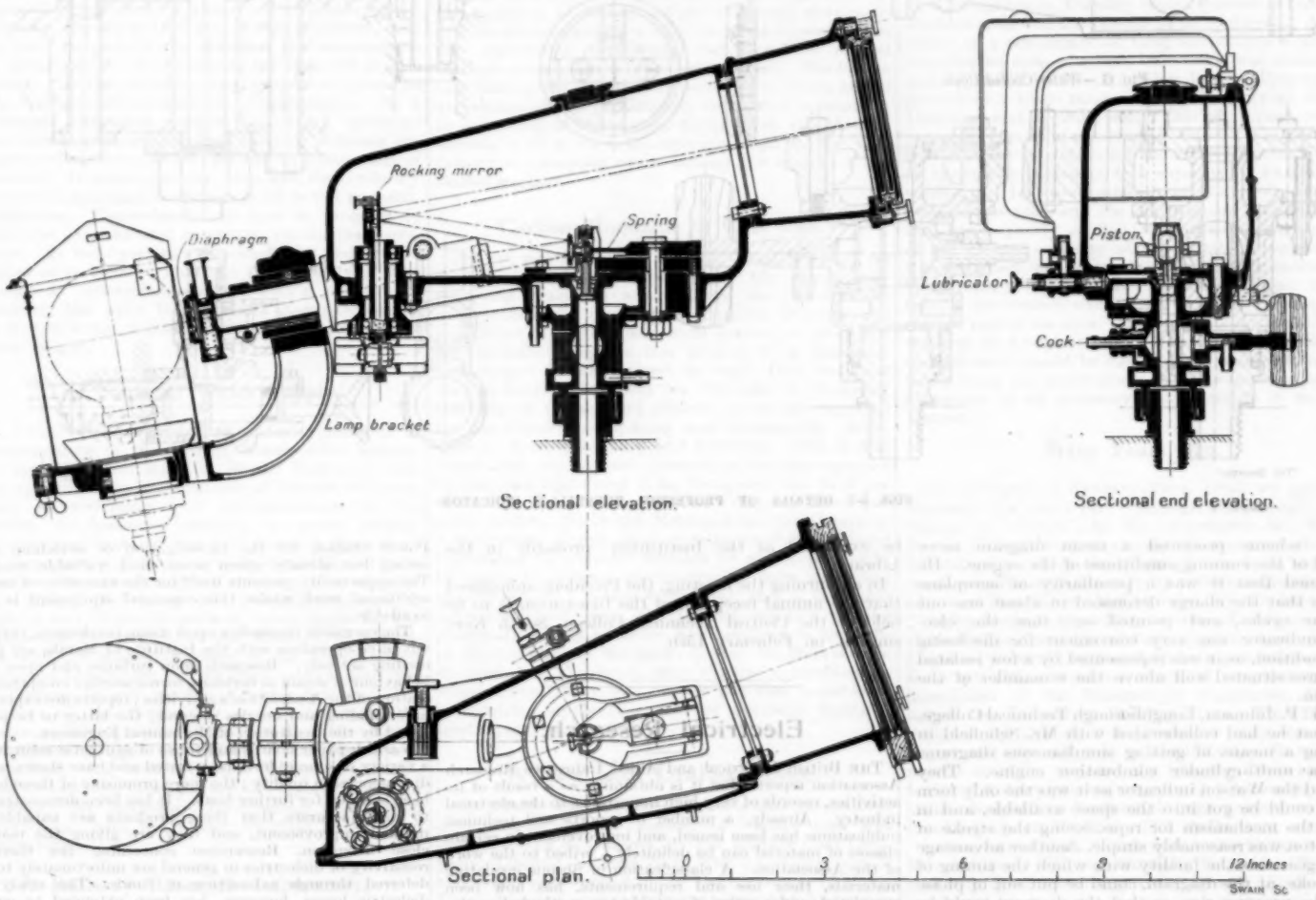


FIG. 1 PROFESSOR F. W. BURSTALL'S OPTICAL INDICATOR

Professor Burstall exhibited a number of lantern slides illustrating his optical indicator, and a selection of cards taken with it. Some of these cards were especially interesting, one, for instance, showing plainly that the engine piston rings were loose, and were allowing the pressure to escape. Professor Burstall said that it was his aim to keep down the number of cycles passed through in the preparation of a diagram, and while the number might amount to two for a comparatively slow speed engine, there might be as many as eight cycles represented on one card with an engine running at, say, 2000 revolutions per minute. When indicating at these high speeds the chief difficulty was, he said, to eliminate the vibration caused by the engine itself.

Mr. Wood's paper was presented by Mr. W. Sydney Smith, superintendent, Royal Aircraft Establishment, S. Farnborough, who said that the pioneer work on the electrical indicator for aeroplane engines was initiated by the late Squadron Leader G. H. Norman. The idea then was to get simultaneous cards from all six cylinders of the engine, but the task proved to be too difficult. Norman suggested the broad principle of the indicator, which was subsequently developed by Mr. Wood, and is described in the paper.

After Mr. Smith had presented the paper, Mr. Wood made some additional remarks, in the course of

which he said that it was quickly decided at Farnborough that one of the first requisites for success was the elimination of inertia in the indicator; it was also desirable to avoid the effects of the engine temperature on the instrument, and to cut out vibration. All these qualities were present in the electrical indicator.

No attempt is made when using this indicator to secure a diagram from a single cycle in the cylinder, but several cycles are combined, and two points on the curve are obtained from each cycle. Mr. Wood said that he thought it was a better policy to prepare the diagram from a number of cycles, as was the case with the electrical indicator, rather than from only one or two cycles, as Professor Burstall did. The former scheme produced a mean diagram more typical of the running conditions of the engine. He mentioned that it was a peculiarity of aeroplane engines that the charge detonated in about one out of four cycles, and pointed out that the electrical indicator was very convenient for disclosing this condition, as it was represented by a few isolated punctures situated well above the remainder of the diagram.

Mr. W. P. Johnson, Loughborough Technical College, said that he had collaborated with Mr. Schofield in devising a means of getting simultaneous diagrams from a multi-cylinder combustion engine. They adopted the Watson indicator as it was the only form which could be got into the space available, and in which the mechanism for reproducing the stroke of the piston was reasonably simple. Another advantage of the gear was the facility with which the timing of the stroke, at the diagram, could be put out of phase with the pressure rise, so that the diagram could be stretched out and any special part of the stroke studied minutely. He thought that it was better, in optical indicators, to use two mirrors with independent motions, rather than combine the two motions in one mirror.

Mr. D. R. Pye, Cambridge University, said he had had some experience with the Collins micro-indicator, which possessed the great merit of having no pivot or sliding joints. It might be thought that it would be difficult to get accurate results with a diagram measuring only 3 mm. by 2 mm.; but, as a matter of fact, the graph made by the instrument was very convenient for exact reading. It was produced by a fine point pressing on a thin sheet of transparent celluloid, and when viewed through a microscope appeared as a narrow black line bordered on each side by white. Mr. Pye said that it was possible to read this line to within 0.01 mm., and that different observers would produce consistent results. He himself had taken good diagrams from an engine running at 1000 revolutions per minute, and found that they were repeated in the same form. He thought that the spherical—not merely barrel shaped, but truly spherical—piston was preferable to the cylindrical type, as the latter always tended to crowd over to one side of the cylinder and leave all the clearance on the opposite side. He had found in a pressure recorder one way out of the difficulty of making a piston tight, yet free, by inverting the apparatus and covering the piston with castor oil. He found that the oil did not pass the piston in sufficient quantities to spoil the diagram, while its mass was not sufficient to affect the inertia of the moving parts. He thought that the slight waviness sometimes produced in the Collins diagrams was caused by a torsional vibration of the stylus arm, and had nothing to do with the periodic vibration of the spring itself.

A fine collection of indicators, some of great historical interest, had been arranged by Mr. Pendred in the lecture hall in connection with the meeting, and at the urgent request of several members, headed by the President and Mr. Patchell, Mr. Pendred undertook to try to persuade the owners of these instruments to leave them at the Institution until the discussion of the papers is resumed on February 9th. We understand that the makers have agreed, and that the instruments may be examined at the Institution—probably in the Library.

In adjourning the meeting, the President announced that the annual reception of the Institution is to be held at the Central Technical College, South Kensington, on February 15th

FIG. 2.—*Spring.*

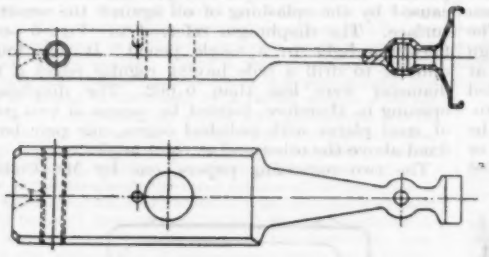


FIG. 3.—*Spring Setting Plug.*

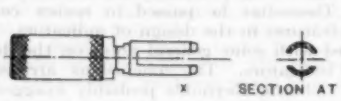


FIG. 4.—*Spring and Piston*

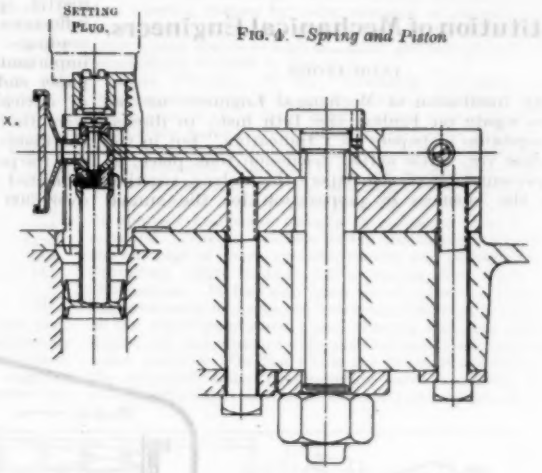


FIG. 5.—*Diaphragm*

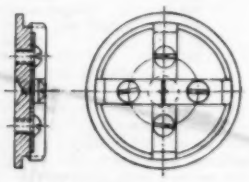


FIG. 6.—*Water-Cooled Cock.*

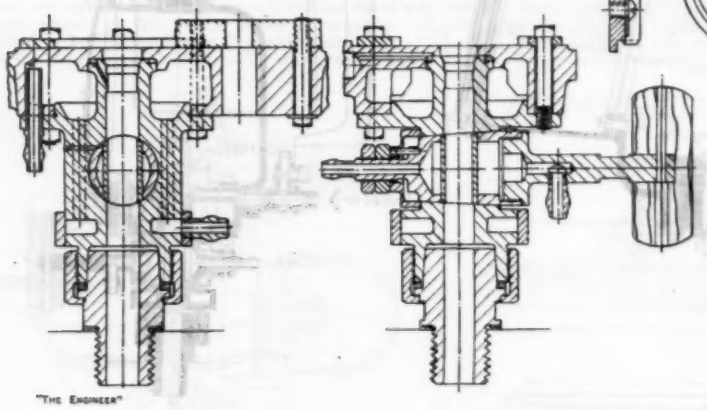
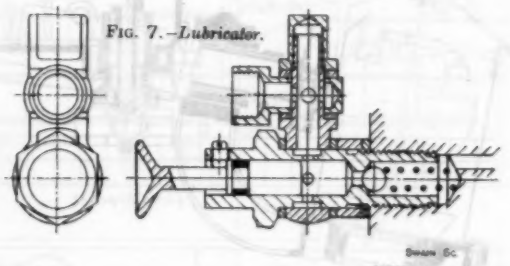


FIG. 7.—*Lubricator.*



FIGS. 3-7—DETAILS OF PROFESSOR BURSTALL'S INDICATOR

Electrical Research.

THE British Electrical and Allied Industries Research Association reports that it is obtaining, as a result of its activities, records of very high importance to the electrical industry. Already, a number of reports and technical publications has been issued, and improvement in certain classes of material can be definitely ascribed to the work of the Association. A classification of fibrous insulating materials, their use and requirements, has now been completed, and a series of suitable test methods has also been developed. These are the basis of purchasing specifications which the Association is now drafting for materials of this group. Experiments upon the heat-resisting properties of composite insulating materials are now completed; sufficient data have been obtained to draft a specification dealing with these properties. At the same time, a provisional classification has been drawn up of the moulding properties of composite insulators, and attention given to the effects of oils upon these materials.

A full report is expected upon the whole of the investigations on porcelain; these include tests of electric strength up to 300 deg. Cent., and resistivity tests to 1200 deg. Cent.; samples for furnace work are not yet tested. Progress has been made upon the study of porosity by electrical methods, and upon uniformity of vitrification. For certain researches upon porcelain, the Association is co-operating with Government Departments, notably with the General Post Office, in the study of surface deposits.

Work upon micanite, embracing a wide range of physical, mechanical, and electrical tests is almost complete, and a comprehensive report will shortly be issued upon this material. The study of mica has proceeded as far as the mechanical properties. Researches upon insulating oils are directed towards the improvement of the electrical characteristics, to the determination of physical constants, and to the phenomena of heat transference. Sludging tests are under discussion with foreign experts, and it is believed that these may be simplified. Oil purification by the use of centrifugal separators has been most promising, and the merits and limitations of available machines for this purpose are being studied. The electric strength of insulating oils is the subject of a detailed investigation, in which the superiority of the horizontal position for spherical test electrodes has been definitely established. It is also hoped to develop a test method not requiring the expensive high-tension equipment now necessary. The section of the Association dealing with conductors has in preparation reports upon the heating of buried cables, and upon the mechanical properties of overhead line materials; a report already issued dealing with wooden poles for overhead lines has raised some important questions and will lead to an extension of the tests.

Amongst the most important of the Association's activities are the researches upon electric control apparatus; it is disturbing to learn that certain of these are held up pending the provision of the necessary facilities and funds. The value of these researches, especially to large users and suppliers of electricity, is such that a special appeal is made for support. For instance, the unique installation of test apparatus erected at the Carville Power Station for the investigation of switching and arcing has already given some most valuable results. The opportunity presents itself for the execution of much additional work whilst this expensive equipment is yet available.

The corrosion researches upon steam condensers, carried out in co-operation with the Institute of Metals, are proceeding actively. Research upon turbines and upon the behaviour of steam in turbines, forms another co-operative feature of the Association's activities; reports are expected upon blading and nozzles research, the latter to be published by the Institution of Mechanical Engineers.

Varnish-paper boards and tubes of synthetic resin from a variety of sources have been tested and have shown wide divergencies in quality; the more promising of these have been selected for further tests. It has been demonstrated to manufacturers that these products are capable of marked improvement, and they are giving the matter close attention. Researches concerning the thermal resistivity of dielectrics in general are unfortunately to be deferred through exhaustion of funds. The study of dielectric losses, however, has been extended to cover radio frequencies, and good progress has been made in the application of cathode ray tubes to this investigation. Various interested technical bodies have received recommendations covering the heat-resisting properties of dielectrics, and methods of test are being developed to deal with every branch of insulating materials. A report just received shows that some quite unexpectedly important features are apparent in the relative accuracy of laboratory and workshop tests for di-electric strength, and these are to be further investigated.

It will be seen that the scope of the Association covers the whole field of electrical research, and that valuable work is also being done in allied subjects. A full record of the progress of all the various activities of the Association may be found in the half-yearly progress review just issued.

BY means of a carrier current, the American General Electric Company has succeeded in transmitting speech over electric power lines carrying 70,000 volts. The tests were made over the high-tension transmission lines connecting the Highland town sub-station of the Pennsylvania Water and Power Company with its hydro-electric plant at Holtwood, on the Susquehanna River, a distance of 40 miles. Conversations were carried on under every possible condition that might occur on a power transmission line, such as short circuits, earthed and broken wires. The equipment consists of a detector and two amplifier tubes. Tuning is not necessary, as the wave length and other characteristics are always the same. Since carrier current travels on a wave length of 15,000 m., there is no possibility of interference from radio broadcasting stations. Fifty-watt sets, as tested, are capable of maintaining communications for a distance of 85 miles. Larger sets of 250 watts are being made by the General Electric Company, which intends to make it possible to extend the distance of communication to 260 miles.

A Seven-Day Journal.

A New Element.

FOR some thirty years or so considerable interest has been attached by chemists to an element of atomic number 72, indicated by the periodic classification, but not known otherwise. In 1895 Thomsen, of Copenhagen, promulgated the view that the element should be tetravalent and homologous to zirconium. Last year Dauvillier, at Paris, announced the discovery of an element of atomic number 72 in a mixture of rare earth metals, and Urbain identified it with an element which he called celtium, the presence of which he had previously suspected in the same source. In a communication to the editor of *Nature*, appearing in that journal's issue of the 20th, MM. Coster and Hevesy, of the Copenhagen Institute of Theoretical Physics, traverse the view that the element is a rare earth, and give reasons why it must, in accordance with Thomsen's original pronouncement, be a homologue of zirconium. They announce that following up this line of argument, they have subjected extractions of zirconium minerals to investigation by means of the X-ray spectrum, and that they have definitely detected the existence in the extractions of an element of the required atomic number. To this element they propose to give the name hafnium—from Hafniae, Copenhagen. In a Norwegian zirconium mineral the X-ray spectrum lines were so intense as to lead them to estimate the quantity of the new element present at a minimum of 1 per cent. It seems probable, they add, that ordinary zirconium contains at least from 0.01 to 0.1 per cent. of hafnium. Experiments are now in progress to isolate the element and determine its chemical properties. It may perhaps be added that the atomic number of an element indicates the sequence of that element as determined by Moseley's method of measuring the wave length of its X-ray emissions, and that it is not identical with the more familiar atomic weight.

The National Water Supply.

A STANDING Advisory Committee, consisting of representatives of the British Waterworks Association and the Institution of Water Engineers, has been appointed by the Minister of Health with the object of conferring with representatives of the Ministry on questions relating to water supply. The first joint meeting was held towards the end of last week, and at it there were discussed the steps to be taken for formulating the outlines of a national water policy, the survey of the water resources of England and Wales at present being made by the Engineering Department of the Ministry, in accordance with the recommendation of the Water Power Resources Committee in its final report, and the standardisation and testing of water fittings. The members of the Committee are as follows:—Mr. Musgrave, Metropolitan Water Board; Mr. Atkey, Nottingham Water Committee; Mr. Blackburn, Sunderland and South Shields Water Company; Lieut.-Colonel Davidson, Liverpool Corporation Water Engineer; Mr. Macaulay, Birmingham Corporation Waterworks; and Mr. Terrey, Sheffield Corporation Waterworks.

A Railway Research Laboratory.

AT a meeting of the Scottish Centre of the Institution of Locomotive Engineers held in Glasgow on Monday evening last, Professor W. E. Dalby gave an address on "Mechanical Transport and Some of its Problems." Dealing particularly with the problems involved in the locomotive, he reviewed the development of what might be called, he said, the science of the locomotive. For making tests of real value it was, he held, necessary to make use of a complete laboratory testing plant, for road conditions varied too much. Unfortunately, the only source of such test data was America, where testing plants had existed for some time and where experiments had been made which had provided the profession with important data on the working of locomotives. Professor Dalby made the suggestion that a railway research laboratory should be established in this country. The railways had recently been grouped from small into large units, and it ought to be possible for the larger units to establish such a laboratory. The expenditure, he thought, would be very small compared with the technical and scientific advantages obtained.

The Whitefriars Glass Works.

READERS of Sir Walter Scott's "Fortunes of Nigel" will learn with interest and possibly with some regret that almost the last remaining link between the modern City of London and the district known in Oliphaunt's time and subsequently as "Alsatia," is about to be severed by the forthcoming removal of the Whitefriars Glass Works from its present habitation just east of the Temple and between Fleet-street and the Thames to a new establishment at Harrow. The business was founded in 1710 by one William Davis, who chose the site probably because of its nearness to the Thames wharves and also because of the cheapness of the land consequent upon its unsavoury reputation. Succeeding Davis came Alexander Seal, Carey Stafford, Stephen Hall, Hall and Holmes, John Holmes, and, in 1834, Mr. James Powell. The works have since remained in the possession of the Powell family. It is highly interesting to learn that even to-day no machinery is employed in the works for glass blowing or moulding, and that all the operations are carried out by hand after the manner of the ancient glass blowers. The works specialise in such items as decanters and table ware, and to a particular degree in stained glass windows and mosaics. English stained glass window practice owes its renaissance very largely to the Whitefriars work and the co-operation of William Morris, Sir E. Burne-Jones, Sir W. B. Richmond, and other artists with its craftsmen. In such an industry the question of labour supply is bound always to provide some anxiety, for where so much depends upon the individual craftsman's art, suitably skilled workers already trained are hard to find. The firm is now taking this matter very seriously in hand, and is at present giving preparatory courses of instruction to a number of elementary pupils from the Harrow schools with a view to entering them in the new factory as vacancies occur among the ranks of the skilled workers.

Carbon Monoxide in Coal Gas.

AT the meeting of the London County Council on Tuesday attention was called to the recent gas-poisoning tragedies arising from the fracture of mains, and the question was raised whether the proportion of carbon monoxide present in gas used for domestic purposes was subject to a statutory limitation. It was stated in reply that no limit was prescribed, but that for the sake of obtaining information the amount present in the gas supplied by the London companies was occasionally determined. During January and February, 1922, it was found that the amount present in the gas supplied by the Gas Light and Coke Company was 15.8 per cent., by the Commercial Gas Company 12.5 per cent., and by the South Metropolitan Gas Company 7.6 per cent. It was decided to ask the Public Control Committee to consider whether or not steps should be taken to restrain gas companies from supplying gas containing "poisonous fumes," and at the same time to report upon the present position of the electricity supply industry, as illustrated in the case of the boroughs of Hackney, Poplar, St. Marylebone, Stepney, and Woolwich, with a view to establishing whether electricity was or was not now capable of completely supplanting gas for domestic lighting, heating and cooking.

A New Coal Loading Device.

ON Friday last, the working of a new mechanical arrangement for the loading of bunker coal was demonstrated at Glasgow by the Bunker Coal Company, Limited, of that city. The s.s. Tiger, one of the steamers belonging to the Dublin service of Coast Lines, Limited, and at the time berthed at Anderston Quay, was used for the trial, and her off-side bunker was filled in the short period of 30 min. In this system a self-propelled barge takes its place on the off side of the vessel, which allows coaling to proceed simultaneously with the handling of cargo. With this special equipment the total number of men employed in the squad is reduced to eight. The main idea of the invention consists in employing a patented form of digger, which is combined with an elevator and conveyor. All the machinery is electrically driven, the power being generated on the barge. An elevator fixed to a gantry travels the whole length of the barge, and is fed by the digger, which is of the caterpillar type and has an endless chain with buckets attached. The buckets, as they come over the top, deliver into a small hopper, and the coal passes along conveyors to the steamer bunker scuttles. The apparatus loads at an average rate of 80 tons per hour, and is stated to effect considerable saving in both the time and cost of bunkering a ship.

Engineer or Steward?

IF a story told in a recent issue of the *Journal of Commerce* is to be credited, there should soon be an appalling dearth of engineering apprentices, and an overwhelming crush of young lads seeking posts as stewards on liners. It is stated that a well-known engineer of a large shipowning company was some time ago approached by a father who wanted to get his son started as an apprentice engineer. He was told that to send his son to Glasgow or Newcastle for a period of five years would probably cost him some £1000 for lodging and maintenance, and that thereafter the lad might earn a wage as a sea-going engineer. On the other hand, if he cared to pocket his pride and send the boy to sea as a steward, he would receive good remuneration in a very short time. This advice was taken, and the boy sailed to the East as an assistant in the stewards' department of a passenger liner. On the second voyage, he was appointed a deck steward in the first class. The vessel carried about 400 passengers out and home, and on his return to London the young steward banked £700, which he had received in tips over and above his wages. We do not accept any responsibility for the accuracy of this story. In fact, we are somewhat inclined to doubt it, for unless nearly all the passengers were first class, the average tip must have been in excess of £1 per passenger.

The East Midlands Electricity Scheme.

THE Electricity Commissioners opened an inquiry at Nottingham on Tuesday last to determine the East Midland area and the powers to be conferred. As the result of a conference of local authorities a scheme covering an area of about 1000 miles was submitted and explained by Mr. Tyldesley Jones. This scheme provided for three main sources of supply at Derby, Leicester and Nottingham. Having regard to the necessary supply of condensing water, it was proposed that the Derby station on the river Derwent should be ultimately extended to a capacity of 40,000 kilowatts, the Leicester station on the river Soar to 50,000 kilowatts, and the Nottingham station to an ultimate capacity of 250,000 kilowatts on account of the greater capacity of the Trent for condensing water. There was a possibility of further extensions at Burton-on-Trent, and Newark-on-Trent would form a convenient site for a station to develop the eastern part of the area. In all probability the existing stations at Loughborough, Mansfield, Long Eaton, and Ilkeston would be closed down and bulk supply taken from the larger stations. The question of the formation of an Advisory Committee is to be considered.

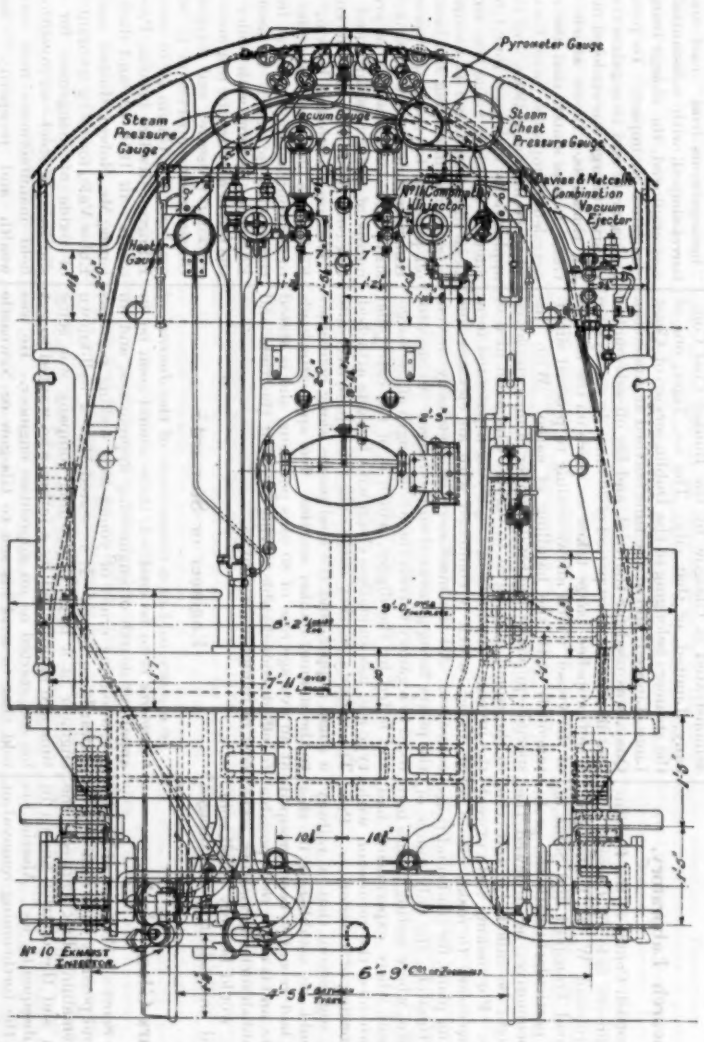
Sixty Years Ago.

IN our issue of January 23rd, 1863, we gave an abstract of a paper on "Railway Telegraphs," read before the "Civils" by Mr. (afterwards Sir) W. H. Preece. The author expressed his regret at the low estimation in which the telegraph was held, and the small consideration given it by railway officials. He admitted that, if used indiscriminately, the telegraph "might become a positive source of danger," but claimed that if it were carefully applied for secondary purposes, it would be found to be a great element of security. In a note we recorded progress in the demolition of the Hungerford Suspension Bridge across the Thames at Charing Cross. This bridge, designed by Brunel, was in use for only seventeen years, and cost all told over £102,000. It was removed to make way for the Charing Cross railway bridge. A description was given of Whitworth's new shells, designed to be fired through armour without breaking up on impact. The shells were made of "homogeneous iron" cast and wrought, and were barrel-shaped, with substantially flat ends. No fuse was employed, the charge being ignited by the heat generated on impact. To prevent that heat acting prematurely and to regulate the time of ignition, the bursting charge was enclosed in a flannel bag of varying thickness. In an article, entitled "Petroleum Gas," it was stated that the estimated quantity of petroleum imported into Europe during 1863 was 50 to 60 million gallons, and that a great number of applications had been found for "this curious product." Its chief value was considered to be its use as an illuminant, and as a source for the manufacture of gas for illuminating and heating purposes. A note on printing by telegraph recorded that the United Kingdom Telegraph Company had that week demonstrated the practicability of printing by telegraph by means of a machine invented by Professor Hughes. Our correspondence columns contained a letter signed "William Cawthorne Unwin," criticising Mr. David Kirkaldy's claim to being the first to pay attention to the contraction of area at fracture as a criterion of the quality of iron. In another letter Mr. E. B. Ellington, dealing with boiler explosions, advocated the use of a hydraulic test once a year to a little above working pressure, and suggested the extension of Government supervision to land boilers as well as marine. Dr. Unwin is, of course, still with us. Mr. Ellington lived to become President of the "Mechanicals" in 1911–12, and died in 1914. In a third letter, Mr. Robert Mushet castigated a Mr. Parry, of Ebbw Vale, for being ignorant of the fact that the use of oxide of manganese for overcoming the red-shortness of steel—an invention "to which the Sheffield manufacturers now owe four-fifths of their wealth and prosperity"—was suggested to the patentee of the process, Mr. J. M. Heath, by Mr. Mushet's father.

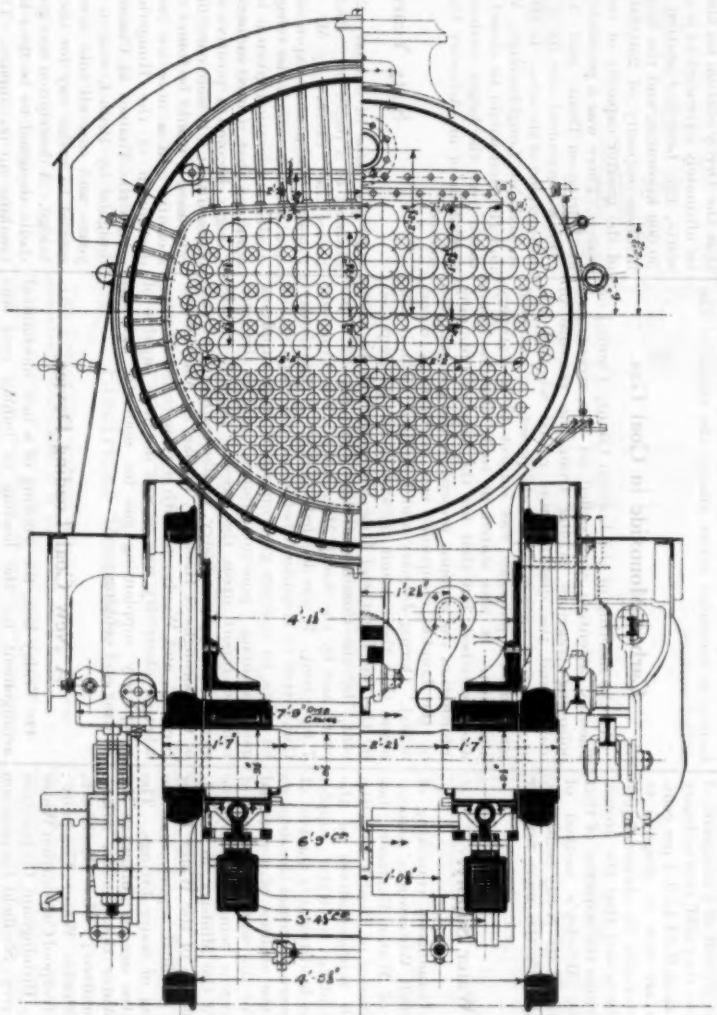
GREAT NORTHERN RAILWAY—THREE-CYLINDER "PACIFIC" TYPE PASSENGER ENGINE

MR. H. N. GRESLEY, M. INST. C.E., DONCASTER, ENGINEER

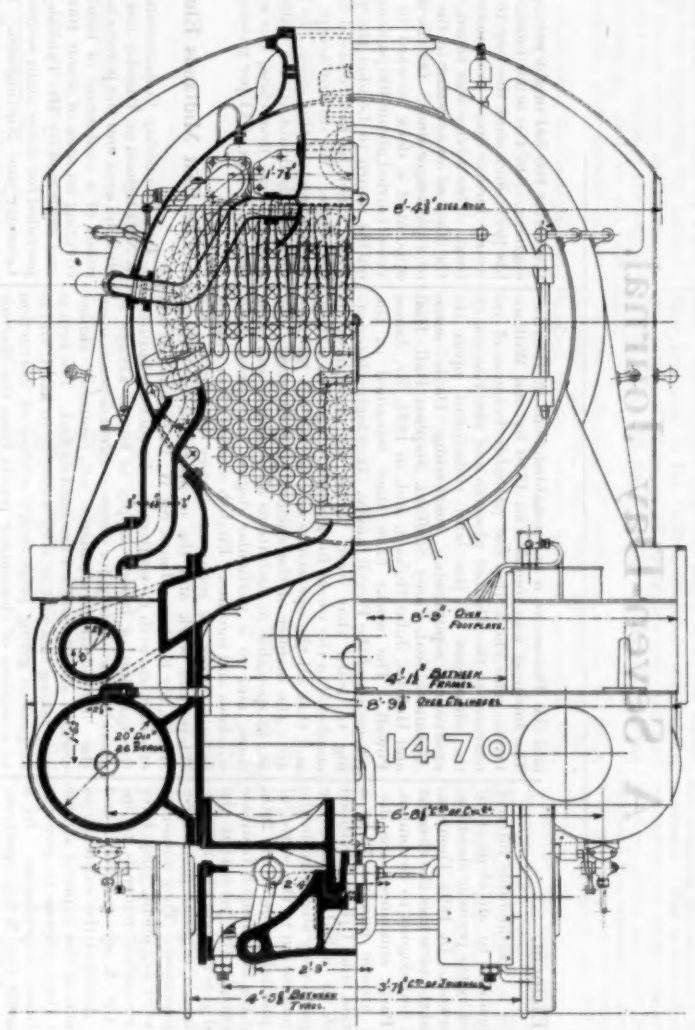
(See page 92)



END ELEVATION.



SECTION THRO' TRAILING WHEEL. SECTION THRO' LEADING WHEEL.



SECTION THRO' A.B. FRONT ELEVATION.

"THE ENGINEER"

SWAIN Sc.

The Ruston-Hornsby Motor Gear.

THE Ruston-Hornsby motor car has now been before the British public long enough to demonstrate that Lincoln is quite as capable of holding its own in this branch of engineering as it has hitherto shown itself to be in the other very important section devoted to heavy agricultural machinery. Finding itself at the close of the war with a well-equipped aeroplane factory for which there was no longer any use, the firm decided to enter the ranks of the motor car industry, and placed upon the market a vehicle rated at 15 horse-power of large seating capacity and at a moderate price compared with other vehicles of a similar type. For this year's machines the policy of building the whole of the car at Lincoln has been adopted, and we were recently invited to pay a visit to the works to inspect the process of manufacture. The two principal alterations which have been made in the 1923 vehicles are in the engine and the gear-box, the latter now being of unit construction with the engine and clutch. The engine is built in two sizes which are practically identical, with the exception of the sizes of the cylinders. In one case the engine is rated at 16 horse-power, and in the other the cylinder bore is increased to give 20 horse-power rating. As we have already dealt with the main features of these cars in our notice of the Motor Car Shows in November last, it is not necessary again to go into details of the mechanism. A tour of the immense works, however, gave the impression that the makers are sparing neither trouble nor expense in their desire to produce a car which will fully uphold the reputation they have made in so many other branches of the engineering industry. The designs for bodies are numerous, and the coach work is of sound workmanship. The frames are of well-seasoned ash machined and assembled in special jigs to ensure interchangeability and reinforced by iron bands to prevent warping. The panels are of steel with acetylene welded joints. The upholstery is high-class, and the "all-weather" body is as near what the term represents as any at present on the market. A feature of this is the design of the rigid side curtains, which are the acme of simplicity and quite efficient. These curtains are fitted with tapered pins, which fit into tapered bushes in the body sides. When not in use the curtains are stowed away in a special box fitted to the hood compartment.

With regard to the works, perhaps the best compliment that can be paid to them is to state that they contain all the tools and equipment which were utilised during the war for the manufacture of 2750 complete aeroplanes and over 4000 aero-engines, including the Clerget and the A.B.C. rotary engines. The machine shops are laid out according to the most modern methods, and cover an area of 47,790 square feet, while the tool room alone covers no less than 10,800 square feet.

AN INNOVATION IN METER READING.

AN innovation in meter reading, by means of which a photograph of each meter face is taken, has been recently adopted on the Toronto hydro-electric system. So far, this system has only been used on demand watt meters, but it is quite applicable to any meter on the company's lines. The great point of the system is that the meter is read with photographic fidelity, and an indisputable record is brought to the office files. There have been no disputes in this case, but if such should occur, the records are at hand, being the means of transporting monthly to the office shelves all the meters on the company's mains. The photographs are taken with a special camera, equipped with an anastigmat lens of short focus, a simple automatic shutter controlled by the operator, making exposures with varying speeds as fast as one-fifth second, and lamps for furnishing light for the exposure. The actual photograph is obtained with the front of the camera against the meter dial by pressing downward an exposure lever. This action automatically turns on the light, opens and closes and automatically locks the shutter, until the film for the next exposure is in position. This prevents the possibility of a double exposure; that is, the superimposing of one exposure upon another.

A Separating Barge for Oily Ballast Water.

THE problem of dealing effectively with oily ballast waters discharged from tankers and oil-burning ships is one of the greatest importance to harbour authorities and shipping owners, especially in view of recent legislation on this subject. By the provisions of the Oil in Navigable Waters Act, 1922, which came into force at the beginning of the year, it is now a penal offence to discharge oil or

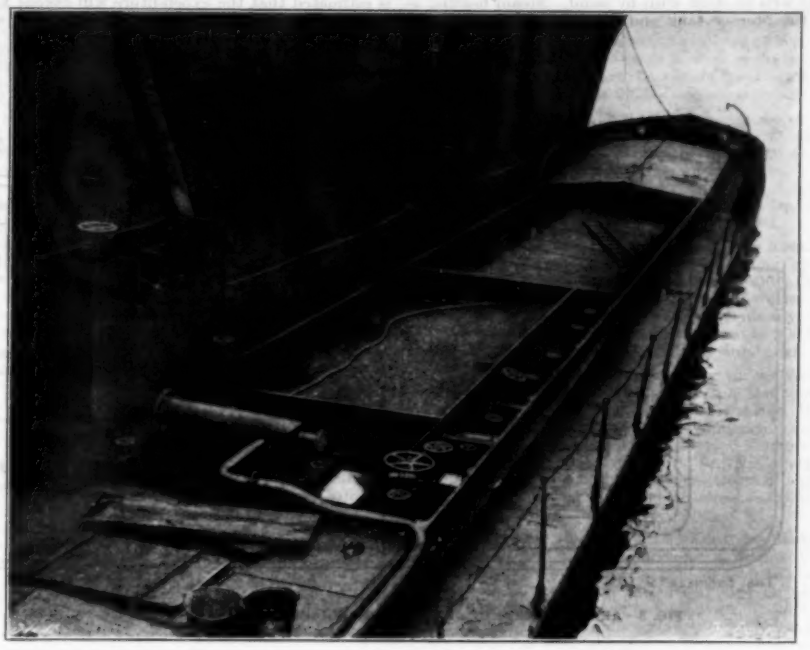


FIG. 1—BARGE IN OPERATION ALONGSIDE A VESSEL

allow oil to escape into the sea within the three-mile limit from the shore. In order to avoid the necessity of a vessel proceeding to sea to discharge the ballast water from her oil tanks, efforts have been made to deal with the oily waters in a special separating barge moored alongside the ship in dock or harbour. In the Journal of our last issue we gave some particulars of a new type of separating barge, which has been designed and constructed by Smith's Dock Company, Limited, of South Shields, in conjunction with the Anglo-Saxon Petroleum Company, Limited. In the present article we are able to give further information concerning this barge and its construction and working, along with test figures.

The separation of the oil from the water takes place on the principle of the surface separation of liquids of differing specific gravities, and the system adopted embodies the results of a large number of experiments on the removal of scum from ballast water, which have been carried out at the works of Smith's Dock Company, Limited.

The barge, which is shown in detail in the drawings we reproduce in Figs. 2 to 4, is divided by a number of transverse and longitudinal bulkheads forming three main compartments for pumping, reception, oil storage, and separating and cascade filtering. The usual mooring bollards are provided fore and aft, along with steering gear, steam connecting pipes and also crew accommodation. A general view showing the barge in operation alongside a vessel is reproduced in Fig. 1.

SEPARATION AND FILTERING.

The oil and water pumped from the ship's compartments falls into a receiving compartment which is connected with the cone separator by a syphon pipe and so provides a steady head, eliminating any pump pulsations which might detrimentally affect the process of separation. These connections are shown in Fig. 4. It will be noted that the first separating compartment or cone filter comprises a series of baffles and cascades formed by a number of superimposed cones, which terminate in the form of a bottle neck. The object of this design is to reduce the free area of the scum rising to the surface, which overflows and passes from the scum trays to the scum storage tank. This part of the apparatus is illustrated in the view shown in Fig. 5. Practically all the oily scum is separated in this first compartment, and the water then passes on to the series of cascade filters which are also provided with means of collecting any scum arising, and returning it to the storage tank. The cascade filters themselves—shown in Figs. 2 and 4—are formed by the transverse bulkheads which extend across the barge and are provided with horizontal slits running the full breadth at the bottom and top alternately. The passage of the water through the filters is indicated by the arrows shown in the elevation view of Fig. 2. The filters are partly closed at the top by sloping plates which reduce the free area, and so increases the thickness of the scum, and facilitates its removal.

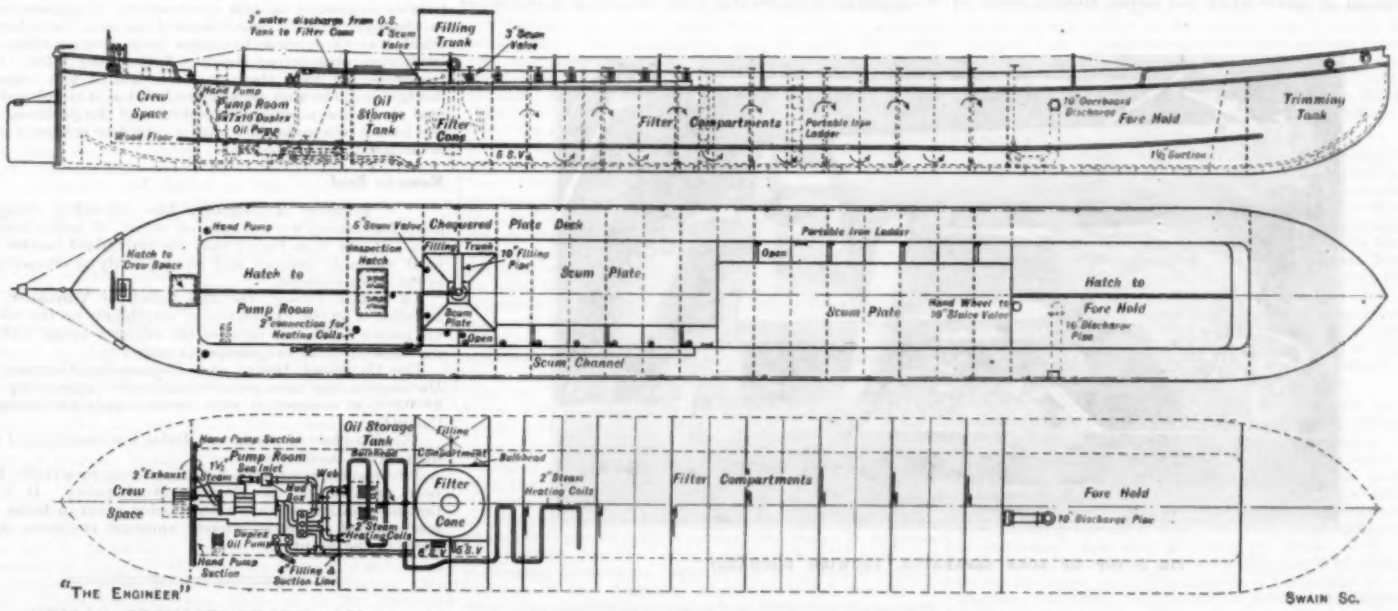


FIG. 2—ELEVATION AND PLANS OF BARGE

PUMPING AND HEATING.

The barge is equipped with a Duplex steam-driven pump by Hayward-Tyler, which is shown in plan in Fig. 2. Connections are made so as to enable the pump to draw either from the river, the filter compartments, or the oil storage tank, and deliver to deck where two delivery branches are provided, one leading to the filters and the other provided for shore connection.

Before beginning operations, the barge is sealed with Control valves are fitted to each compartment. The water discharged from the filters passes out through a valve on the ship's side, which is above the river level, and enables the operator to observe the appearance of the water.

clean water, and the pump on board fills up the filter compartment to the ordinary working level. When the oily water is discharged from the ship the discharge valve on the barge is set by trial to suit steady pumping conditions, and no alteration is required until the tank bottoms are reached and unsteady conditions with a preponderance of scum to be dealt with occur. The discharge outlet is now closed down so as to maintain a steady flow through the filters. When scum alone is being dealt with it becomes necessary to maintain a certain cushion of water in the cone separator, and this is done by allowing the pump on the barge to draw from the river and deliver water to the bottom of the cone separator. During working it was found that scum does not extend seriously beyond the fourth cascade opening, and may quite well be dealt with by hand. Steam heating is fitted to the storage tank and also to the filtering compartments both on the top of the floors and underneath the decks. The heating coils are particularly useful in obtaining an absolute separation of the oil and water in the scum settling tank. The water is circulated through the cone filter until practically pure oil remains in the storage tank, which may be delivered back to the ship or be dealt with ashore as required. In a recent trial about 2000 tons of oily ballast yielded 60 tons of oil, the water being discharged entirely free from contamination. When operations are completed the oily ballast water is heated to effect an absolute separation of scum, and the barge is then ready for the next service. Steam for heating and pumping is supplied to the barge by the ship she is serving.

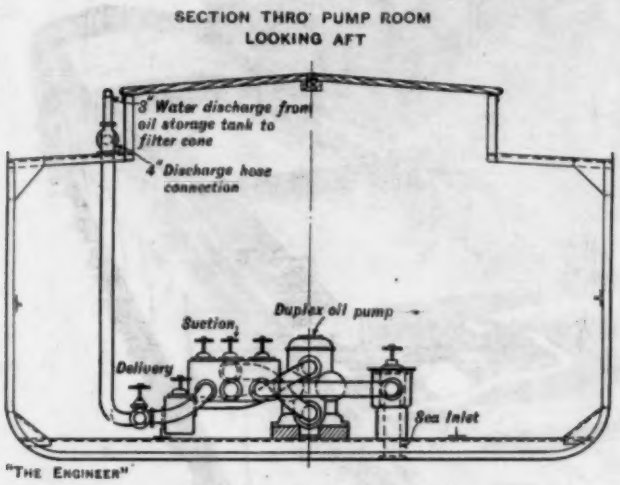


FIG. 3—ARRANGEMENT OF PUMPING MACHINERY

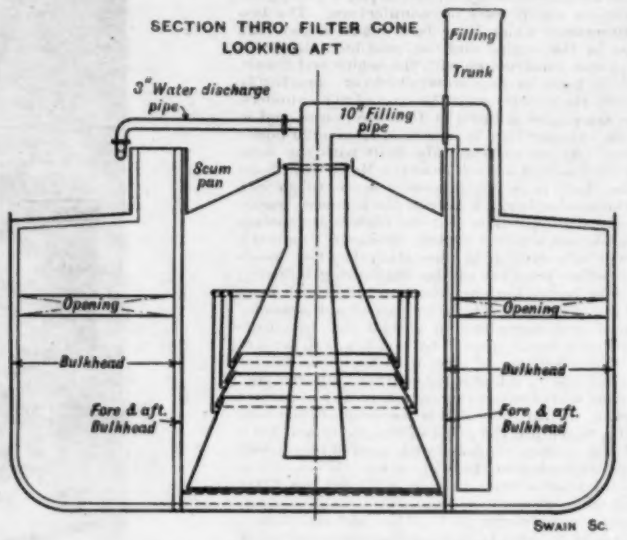


FIG. 4—SECTION THROUGH CONE SEPARATOR

TEST RESULTS.

The 250-ton barge we describe is designed to deal with oily ballast water discharged continuously from any size of ship at a rate of between 180 to 200 tons per hour. The following data are taken from the log book of the ss. Corbis, an oil tanker which had carried Mexican crude oil following on a cargo of creosote. The time occupied in pumping out and treating 3200.6 tons of ballast water from No. 2 and No. 4 tanks is given below :—

Saturday, December 9th	8.15 a.m.: Began discharging Noon : Ceased work for the day
Monday, December 11th	9.05 : Resumed discharging Noon : Stopped pumping (dock-yard meal hour) 2.05 : Resumed pumping 4.45 : Ceased pumping for the day
Tuesday, December 12th	7.55 : Resumed discharging 4.0 : Finished and drained both tanks
Total hours worked ..	17 h. 25 min.
Average per hour.. ..	183.9 tons per hour

The trial was a satisfactory one in all respects, and we understand that throughout the operation no trace of oil from the barge was found floating on the surface of the river.

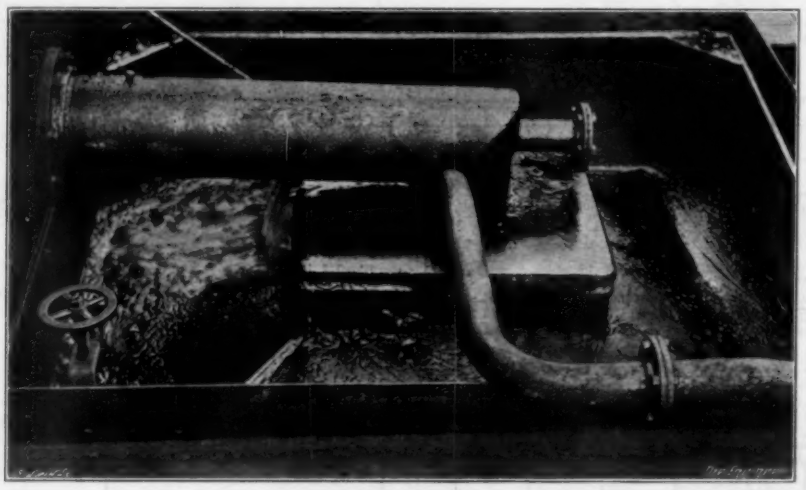


FIG. 5—TOP OF CONE SEPARATOR, SHOWING DISCHARGE

Indian Engineering Notes.

(*From our own Correspondent.*)

BOMBAY, January 6th.

The East Indian Railway.

AMONGST the railways which have received an allotment of funds for new construction from the Government of India is the East Indian Railway, upon which it is estimated that the expenditure will exceed £16,000,000 during the next five years. This railway serves the Raneegunge and Jherria coalfields on the one hand, and Calcutta on the other, and upon this section of line the congestion has hitherto been more serious than elsewhere in India. It is anticipated, however, that the completion of the projects in hand will materially improve the general situation. Besides doubling and quadrupling the track in many places, a large number of marshalling and sorting yards are being considerably extended, and many bridges are being strengthened and rebuilt. The latter include the Lower Sone Bridge, which is the longest in India. Large additions to rolling stock are also contemplated, including the provision of some 10,000 new goods wagons and several hundred bogie coaches. Further, with the idea of speeding-up all descriptions of traffic, it is proposed to install a train control system throughout the line.

Vizagapatam Harbour.

The proposed lay-out of the new harbour at Vizagapatam indicates that when the scheme is completed there will be accommodation for sixty-two ocean-going steamers and an almost unlimited number of coasting vessels and country craft. Vizagapatam is situated on the east coast of India, approximately half way between Calcutta and Madras, which are 1100 miles apart, and the new harbour will, therefore, act as a convenient port of refuge for ships in bad weather on an otherwise harbourless stretch of coast. From the commercial point of view, however, the principal attraction of the harbour will be that, in conjunction with a new railway from Vizianagaram to Raipur, it will open up an immense tract of hitherto undeveloped country in the Central Provinces. Geographically, Vizagapatam is ideally situated for the construction of a first-class port. A spacious lagoon, landlocked save for an entrance creek, already exists, and the harbour will be available for ocean-going vessels as soon as the first wharf has been constructed and the entrance channel sufficiently deepened. The engineer-in-charge is Colonel H. Cartwright-Reid, C.B., whose services have been lent to the Bengal-Nagpur Railway—the sponsors of the scheme—by the British Admiralty.

Navigation in Shallow Waters.

There is evidence that the hydroglisseur is likely to supplant the ordinary motor boat on the shallow rivers of India. About six months ago one of these useful little craft was built by a private individual in the Punjab and created quite a sensation on account of its speed as much as by reason of the way in which it skimmed over sand-banks barely covered with water. Attaining a speed of 40 miles an hour, as compared with the 9 miles an hour of the motor boats employed in river transport in that part of the country, and drawing only a few inches of water, it proved an eye-opener to engineers engaged in various irrigation works. Now comes news that it has been purchased by Government for use in communication work in connection with the Sutlej Valley project, and it is believed that a number of similar craft will be ordered for use in the cross-river mail service which is maintained in many places. Those of my readers who served in Mesopotamia will recall that hydroglisseurs were entirely successful on the shallow wagers of the Tigris roundabout Baghdad, one of them being frequently used by the late General Maude.

Calcutta Drainage.

In my last letter I referred to the serious position which had arisen owing to the silting of the Bidyadhari River, which serves as the outfall for the drainage system of Calcutta. The interim report of a committee specially appointed to investigate the position shows that the trouble originated in the construction of embankments in the spill area by unauthorised parties, the effect of which was to prevent the tides from overspreading the land, thus obstructing the free flow of the tides. It is recommended that the upper reaches of the river be dredged and the spill areas extended, but it is pointed out that this is not a permanent solution of the problem. At the best it is a makeshift until a complete scheme can be formulated and carried out.

News in Brief.

Bombay Municipality has ordered a stamping plant for dealing with municipal refuse of every description. It has been found that the pulverised matter is a most valuable manure and consequently a considerable profit is anticipated.

An Indian Prince, the Raj Saheb of Vankaner, has installed a 60,000 candle-power searchlight on the roof of his palace ; and now none of his subjects living within a radius of 20 miles can escape its eagle eye !

The Cleveland Bridge and Engineering Company, of Darlington, has been awarded contracts aggregating over £400,000 in connection with water supply extensions at Calcutta.

The Tin-plate Company of India has commenced production at Jamshedpur.

Two wave transmission sets, operating rock drills, have been installed by the Bombay Municipality. It is the first installation of wave transmission plant in India, and has aroused immense interest amongst engineers in all parts of the country.

G.N.R. THREE-CYLINDER PACIFIC LOCOMOTIVE.

THROUGH the courtesy of Mr. H. N. Gresley we are able to give to-day several drawings of his three-cylinder "Pacific" type of locomotive, which was fully described in our issue of April 14th, 1922. A longitudinal section and plan appear in a Supplement, and other drawings upon page 90. We hope to reproduce drawings of various details of this engine within a few weeks.

ON account of the excessive inflow of water, the Government is abandoning its oil boring at Roma, Australia, where £35,000 has already been spent.

Railway Matters.

THE scheme for the absorption of three subsidiary companies by the South-Eastern Railway was approved by the Railway Amalgamation Tribunal on the 15th, and of nine subsidiary companies by the Great Western on the 16th.

THE Havre boat train from Southampton was, during a dense fog, in collision with the 6.40 from Portsmouth near Queen's-road on the morning of last Wednesday week. There were no personal injuries, and little material damage. The signals were against the boat train, but we are not in a position to say what warning the driver got from the fog signalman.

AT the half-yearly meeting of the Great Indian Peninsula Railway, on the 19th instant, the Chairman said that sanction has now been received to proceed with the first 30 miles of the Bombay suburban electrification as far as Thana. Steps had been taken to start construction on the first 20 miles of this scheme, and contracts will shortly be let for the track work and special rolling stock.

THE London, Midland and Scottish company has informed the Hackney Borough Council that it has no intention at present to convert the line between Broad-street and Poplar from steam operation to electric traction, although the question will not be lost sight of. We would add that the company has, we believe, no powers to electrify this portion of the old North London Railway.

WE are, as yet, without any information as to the chief engineers and chief mechanical engineers of the London and North-Eastern Railway. All that may at present be announced is that Mr. C. J. Brown, the chief engineer of the Great Northern, has been made "engineer, southern area, G. C. and G. N. sections," and that Sir Vincent Raven, who is described in the official notice as "formerly chief mechanical engineer of the North-Eastern Railway Company," has been made technical adviser to the London and North-Eastern Railway.

ON the 13th instant a mineral train from Treherbert got out of control when descending the heavy gradient into Porth Station, but a signalman was able to send warning of the fact, with the result that the passengers were got out of a standing train before the mineral train ran into it. Something similar to this happened on December 3rd, 1907. The engine of a passenger train standing in the bay line at Porth had assisted a train of fifty-three empty wagons and a 10-ton van from Porth up the Ferndale branch. When returning to its train the driver noticed that some wagons were running back after him. It was dark at the time, and he could not tell how many there were. Actually there were fifty-one and the van. Had he known this he would have attempted to derail some, but he did succeed in reducing their speed from 12 to 6 or 7 miles per hour. The signalman at a box 462 yards from the station saw what had happened and sent a signal to the box at the station. The man there had to make seven lever movements to prevent the engine and wagons running into the bay, but he was able to move only five. In the consequent collision twenty-four passengers were hurt, two of them seriously.

THE report of Lieut.-Colonel Mount on a collision, during a fog, on November 14th last, at Hornsey, Great Northern Railway, was issued on January 17th. To appreciate how, mainly, the accident occurred it should be said that the standard rule 45 (*d*) of all the railway companies provides that in foggy weather or during falling snow trains shall not be allowed to draw forward towards advanced starting signals. There is a proviso to this rule which allows this to be done when track circuit is provided at the advanced starting signal. Drivers, of course, know this rule, and, naturally, assume that when a starting signal, *i.e.*, the signal reached before the advanced starting signal, is lowered during fog they are free to go forward to the next box. At Wood Green track circuit had been provided, but the drivers had not been advised of this, and when, on the evening in question, the driver of an empty carriage train found the starting signal at "clear," he went ahead and passed, in the fog, the advanced starting signal at "danger," and his train came into collision at Hornsey with the East Coast up day Scotch express. Five passengers and three servants were slightly hurt. Colonel Mount thought that although the signals had been in their present position for many years, they might be improved in position, and concluded with the observation that the case should be noted, with others, in respect of the advantages of automatic train control.

THE following changes, affecting chief engineers and locomotive superintendents, have been made in view of the grouping of the eight companies which form the London, Midland and Scottish Railway. Mr. W. A. Paterson, chief engineer of the Caledonian, has retired, and we anticipate that Mr. James Briggs, of the Midland, will do so as well. The divisional engineer for the Midland is Mr. H. P. Miles; for the former Lancashire and Yorkshire, now known as Division B, Mr. W. H. Coomber; for the North Staffordshire, Mr. C. C. Rose; for the Furness, Mr. D. L. Rutherford; for the Northern Division, Mr. D. McLellan; for the Highland section, Mr. Alexander Newlands. All these appointments are under the engineer-in-chief, Mr. E. C. Trench, at Euston. No announcement has yet been made as to Mr. Thomas Keeling, of the Glasgow and South-Western. As announced in this column on the 5th instant, Mr. George Hughes is the chief mechanical and electrical engineer, and Sir Henry Fowler is the deputy chief mechanical engineer and the mechanical engineer for the Midland Division. Captain H. M. Beames is the mechanical engineer at Crewe, Mr. G. N. Shaweross at Horwich, Mr. J. A. Hoskham at Stoke, Mr. W. Pickersgill at St. Rollox, Mr. R. H. Whitelegg at Kilmarnock, and Mr. D. C. Urie at Inverness. No announcement has yet been made as to any changes in the administration of the signal and telegraph branches. Mr. F. W. Dingley retains his position of superintendent of motive power for the old London and North-Western. Mr. J. E. Anderson, the works manager at Derby, has been made superintendent of motive power for the remainder of the grouped system.

Notes and Memoranda.

SPEAKING in the Belgian Senate recently, the Minister for the Colonies, M. Franck, stated that radium could be produced in the Congo in such quantities as would render Belgium the supplier of the world. Eight grammes of radium bromide are to be reserved for the use of the hospitals in Belgium.

ACCORDING to a report from Madrid the borings effected in the Serrania de Ronda (province of Malaga) in search of platinum have given satisfactory results, as they have demonstrated the existence of the metal in appreciable proportions. The alluvium, which is volcanic, is of the same nature as that of the Urals. Borings are being continued.

THE value of hydro-electric energy as conserving coal consumption in Canada may be partly gauged by the fact that only 1½ per cent. of the total coal consumption takes place in central electric power stations. In the United States 2.6 per cent. and in the United Kingdom 9.7 per cent. of the total coal consumption occurs in these stations. In 1920 over 97 per cent. of all the power output from central stations in Canada was produced from water power. The steady growth of water-power development during the past two years indicates that this proportion will be maintained or even increased.

THE works of exploration carried out by the Mines Department in the Alhama lignite basin, Murcia, show that well-defined strata exist, of which four extend for a fairly long distance; two other strata have as yet been only partly prospected. The thickness varies from 0.60 m. to 1.80 m. Analyses made seem to show that the quality of the fuel improves with the depth. The area investigated up to the present is 900 hectares, containing a great quantity of available fuel. It is intended to erect electric works on the spot in order to utilise the lignite by means of the American pulverisation method, instead of by distillation, to which the material does not lend itself.

IN a review of China as a market for machinery, the *Journal* of the British Chamber of Commerce in Shanghai says that while the machinery trade is not as flourishing as it might be, Great Britain is taking a very fair share in what is being done; and while the wisdom of the short credit policy of British manufacturers and merchants is often questioned, the very fact that British goods are making such progress does not seem to indicate adverse criticism on the part of the Chinese. Experts and others interviewed on the question of the future of British machinery trade in China are all optimistic; and certainly if figures can prove anything, they should prove the British predominence in the trade.

ARTICLES made of a 15 per cent. aluminium-iron alloy develop, on being heated to redness, a thin but highly resistant surface layer of aluminium oxide which does not scale, and prevents further oxidation of the metal, so that no appreciable alteration of the surface is noticeable after heating at a high temperature for one hour in a strongly oxidising atmosphere. The alloy gives good castings and may, with care, be forged. Similar results are obtained by treating soft-iron articles by the Alitier process, which consists in heating the metal for some time, surrounded by a powder containing aluminium, whereby the latter penetrates the surface of the iron for a certain distance and forms a surface layer of iron-aluminium alloy that behaves in a similar manner to the 15 per cent. alloy described above. An iron crucible treated by this method was practically unattacked after heating to 1000 deg. Cent. for sixty hours, whereas a similar untreated crucible was destroyed in twenty-four hours.

THE theoretical advantages gained by melting brass in electrical furnaces have been summarised as follows:—(1) Melting may take place in a neutral or reducing atmosphere, thus minimising loss of metal by oxidation and improving the quality of the product through freedom from oxides. (2) Metal of crucible quality may be obtained without the use of crucibles. (3) Melting may take place in a tightly closed chamber, or at least in one free from the constant passage of the products of combustion of fuel, and thus losses of volatile metals, such as zinc and lead, may be reduced. Contamination by sulphur from fuel is avoided. (4) In some types of electric furnaces the temperature may be more readily controlled than in fuel-fired furnaces. (5) In some types of furnaces the molten metal is thoroughly stirred, thus giving a uniform product, even with large heats. (6) There is no handling or storage of fuel, such as coke, coal or oil, and no ashes have to be removed. The cost of power can be accurately predicted over longer periods than the cost of fuel. (7) Working conditions about the furnaces are less dangerous to health and safety of workmen, provided suitable types of furnaces are chosen. (8) The above advantages may be obtained in furnaces of larger capacity than can be used satisfactorily in the fuel-fired crucible types, with resulting greater uniformity of product, lower labour cost, and increased production.

IT has long been known that the standard brass consisting of copper and zinc will lose the zinc at a greater ratio than the copper under a variety of circumstances; even when constantly in contact with a fairly pure water, the zinc may be so completely removed as to leave nothing but a brittle porous mass of copper. Mr. Ralph B. Abrams, of the senior class in Chemical Engineering, University of Wisconsin, presented a paper at the forty-second general meeting of the American Electro-chemical Society in September, describing a research to determine the manner in which this removal of zinc takes place under ordinary conditions. His conclusions, as given in the *Journal* of the Franklin Institute, are as follows:—The first step is the dissolving of the brass as a whole. The copper in solution then re-deposits replacing brass as a unit. This re-deposition will not take place unless there is some means of holding the dissolved copper in contact with the brass. This can be accomplished in two ways, one by the presence of a membrane, the other by having a large excess of dissolved copper present. Obviously, this latter possibility is a remote one, especially so far as natural conditions are concerned. The membrane may be anything whatsoever, so long as it performs the function of keeping the dissolved copper in contact with the brass. Cuprous chloride is the usual membrane. Whether or not dezincification shall take place can be controlled by merely supplying or taking away the membrane.

Miscellanea.

SURVEY by the Canadian Pacific Railway of the mineral resources in the railway belt of Vancouver Island, preparatory to the development of these resources, will be completed, according to *Canada*, during 1923.

THE construction of the first bridge over Burrard Inlet, to connect North Vancouver with Vancouver, has been assured by a recent vote of the ratepayers. The bridge, which will be an unusually large one, will be built at the Second Narrows. Until now a ferry has been utilised to connect the two cities.

THE Department of Public Works, Bogotá, Republic of Colombia, has entered into a contract for the construction of two lighthouses, one in the port of Riochacha, and the other in the island of El Morro, in the archipelago of Tumaco. The estimate of expenditure upon both constructions is placed at 30,350 pesos (national currency).

ON February 1st Sir Oliver Lodge is to deliver the Silvanus Thompson Memorial Lecture at the Finsbury Technical College, E.C., and he will take as his subject "The Basis of Wireless Communication." Sir C. A. Parsons, K.C.B., will occupy the chair. A conversazione will be held subsequently, at which Dr. Thompson's apparatus and paintings will be exhibited.

CONTRACTS have been signed for the installation of a 5000 horse-power addition to the existing hydro-electric facilities at the Anyox smelter of the Granby Consolidated Mining Company, British Columbia, states Mr. H. S. Munroe, general manager of the company. The new addition will cost in the neighbourhood of 200,000 dollars, and will be ready for service about July next.

WORK is proceeding, according to the *South African Mining and Engineering Journal*, on the foundations of the port grain elevators at Capetown and Durban, and construction work has been commenced on seventeen of the thirty-four inland elevators. Tenders have been accepted, and the contractors for the erection of the elevators and the supply and installation of the machinery and plant are now occupied on their respective sections of the work.

THE iron ore deposit of the Kent coalfields possesses interest at the present time, as a company has been formed to develop this area. The deposit has been proved by boreholes and found to extend over an area of 4000 acres. It varies in thickness between 7ft. and 16ft., and an analysis of a continuous core 12in. in thickness showed 32 per cent. of iron, phosphorus 0.4 per cent., and sulphur 0.05 per cent., while the proportion of lime, silica and magnesia indicated that it is almost a self-fluxing stone.

ACCORDING to a statement issued by the American General Electric Company, three New York ferry boats being built by the Staten Island Shipbuilding Company will each be propelled by an eight-stage condensing Curtis marine type turbine. Each boat will also be equipped with a turbine-driven alternating-current generator that will, in turn, drive two marine type two-speed induction motors having double squirrel-cage rotors. The high-speed winding will deliver 2100 shaft horse-power at 176 revolutions per minute, and the low-speed winding will deliver 100 shaft horse-power at approximately 122 revolutions. The ship may be manœuvred either ahead or astern.

WE have been asked to state that the 1125-kilovolt-ampère motor supplied to the Powell Duffryn Company by the British Thomson-Houston Company, and referred to in our annual review of the year's progress in electrical engineering, is a synchronous machine, and not a synchronous induction motor as stated. The comparatively small starting torque of the former type of motor has in the past been a disadvantage, but this has been overcome by the British Thomson-Houston Company without resorting to the synchronous induction type of machine, which is considered to possess certain inherent disadvantages which are not present in the ordinary salient pole type of motor.

THE Nigata Ironworks, which some years ago concluded an arrangement with a British firm for the building and sale of Diesel engines in Japan, has made considerable progress, and a special factory has been built at Kamata for the construction of Diesel engines. The first Japanese vessel to be fitted with this type of engine was a 600-ton passenger boat belonging to the Osaka Shosen Kaisha, and it is now reported that owing to the satisfactory results obtained the Kokusai Steamship Company has also decided to introduce Diesel engines on its freight vessels. The Mitsui Bussan Kaisha is also considering the installation of Diesel engines on certain cargo boats, as well as the Kawasaki Dockyard, which has three standard ships of 9700 tons each now in course of construction.

A CONFERENCE on "Industrial Fuel" will be held next spring in Paris under the patronage of M. Le Trocquer, Minister of Public Works, and with the support of the Société d'Encouragement pour l'Industrie Nationale. The proposed agenda include discussions on the assay of various fuels, rules for testing boilers, producers, and furnaces, standard methods of making measurements required in controlling the use of fuel, construction of furnaces, use of pulverised fuel and of low-grade fuels. Any communications concerning the conference should be addressed to the Président de la Commission d'Utilisation du Combustible, Ministère des Travaux Publics, 246, Boulevard Saint-Germain, Paris. Notices and reports concerning the conference will be published in *Chaleur et Industrie*.

WORK in China on the excavation of the proposed canal between Chekian and Tientsin will, according to the *Trans-Pacific*, start shortly, following a decision reached recently by the American International Corporation and the Industrial Bank of Japan concerning the supplying of funds. The project was first mooted by the American corporation, and Japanese interests were admitted later. Preliminary survey work has been completed at a cost of 1,000,000 dols., of which the American company supplied 600,000 dols. The estimated cost of the canal is 7,000,000 dols., and toll charges will furnish the income from the undertaking. The Oriental Development Company protested to the Government, stating that the canal endangered its interests, but the Government refused to consider the protest.

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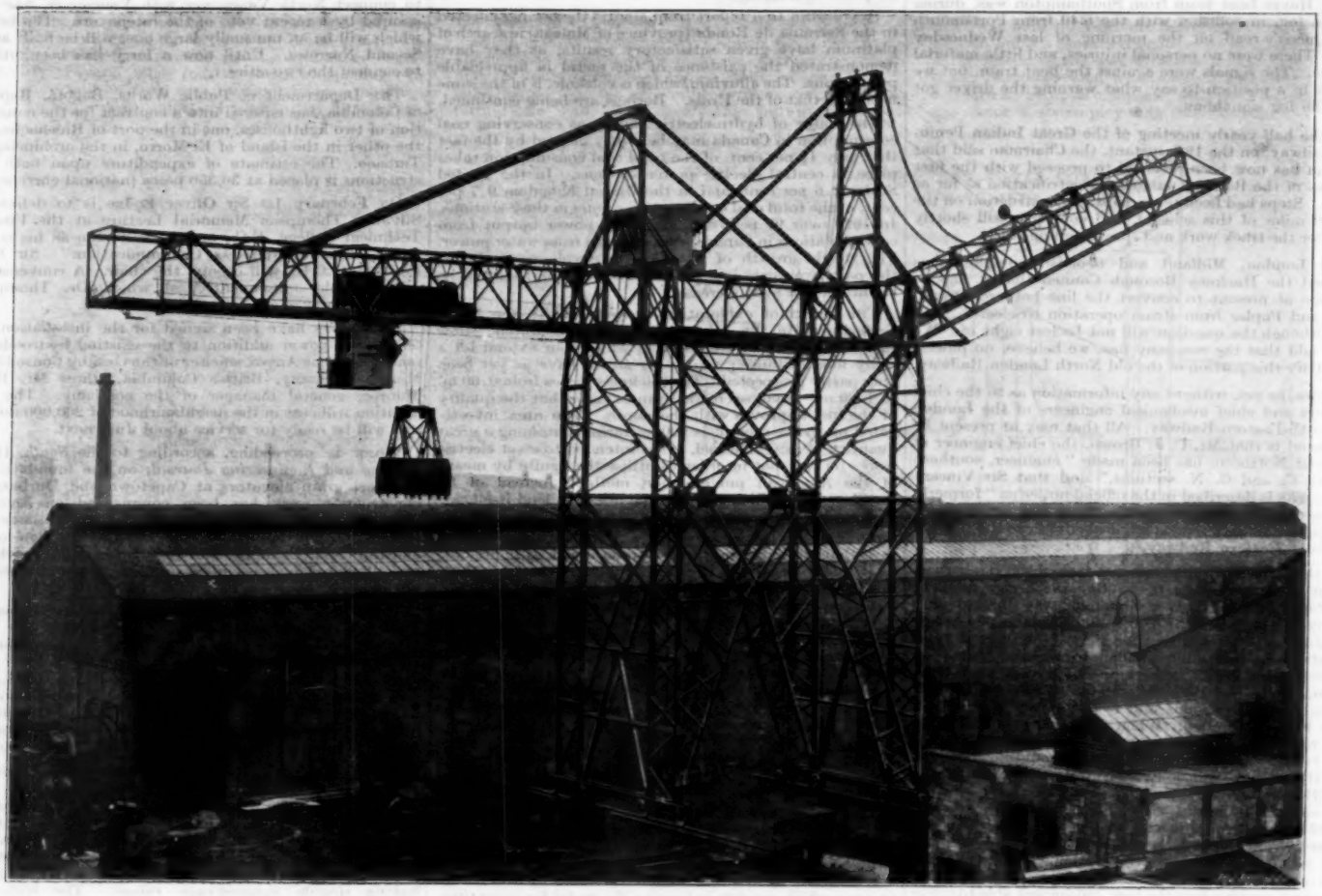
(*For description see page 98*)



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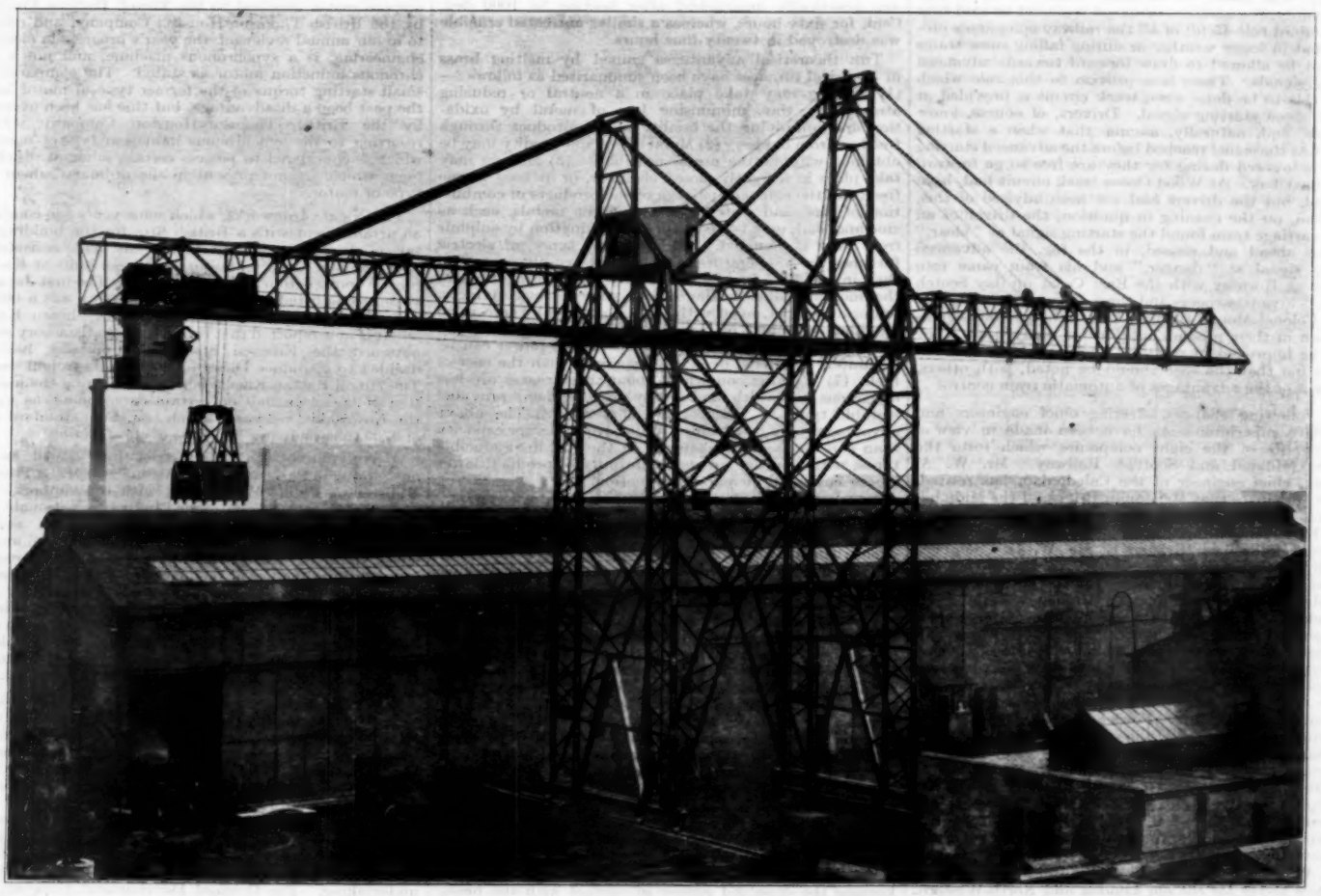

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THE ENGINEER.

JANUARY 26, 1923.

Research on Cutting Tools.

GREAT as has been the progress made during the past twenty years in the design of machine tools and the manufacture of tool steel, our knowledge regarding the cutting of metals remains deficient at a hundred important points. The field for research is still so great that no one can hope to investigate it in all its bearings. The tool, the machine and the work constitute a combination which in the workshop has to be dealt with as a whole, but which for experimental purposes presents so many major and minor variables that it is impossible to study all aspects in one connected series of investigations. The tool, its nature and form, and the influence of feed and speed upon its cutting efficiency and durability have been the subjects of many researches in the past, but while any one investigation may appear to present fairly decisive results and permit the drawing of fairly definite conclusions, it is generally found that the results are either in serious disagreement with those of other investigators or are quite incomparable with them by virtue of different conditions as regards the work, the machine and other experimental factors. Progress in these circumstances must clearly be slow—so slow, in fact, that we may well doubt whether the cutting of metals, in spite of the development of the most refined means and apparatus for measuring the various quantities involved, will ever approach to the condition of an exact science. The latest contribution to the subject, the report of the Lathe Tools Research Committee of the Manchester Association of Engineers, published on Monday by the Stationery Office on behalf of the Department of Scientific and Industrial Research, brings that end, so far as can at present be seen, but little nearer. The results obtained under Mr. Dempster Smith's supervision are in many respects satisfactory and decisive when considered by themselves; but taken in conjunction with those already accumulated by others they reveal contradictions and irreconcilabilities which clearly call for settlement one way or the other before an attempt is made to build up further work upon them.

We cannot, in the space at our disposal, review the new Manchester report in full. It covers an investigation designed to discover a heat treatment for tool steel that would give consistent results, an investigation aiming at the correlation of the durability of a cutting tool with its hardness or its magnetic or electrolytic properties, an investigation of durability as affected by cutting speed, shape, cutting angle, nose radius, cross section, lubricant, &c., and a study of the component forces acting upon a tool and the power consumed by cutting with it. To our mind, by far the most important section of the report is that devoted to the durability of cutting tools as influenced by changes in the speed, depth of cut and feed. That aspect of the matter has, of course, been repeatedly investigated and discussed, but our lack of settled conclusions regarding it is still as great as our need for them. In a general way, practical impressions would lead us to expect that the durability of a tool would decrease with an increase in the cutting speed, other conditions being constant; or, in other words, that the durability and speed would be related hyperbolically by some such expression as $V T = \text{constant}$. Most of the experiments on the subject bear out this general impression, although the relationship is found to be not that of a rectangular hyperbola, but to be expressed by an equation of the form $V T^n = \text{constant}$. The value of the constant varies with the form and nature of the tool, and with the rate of feed and depth of cut. The value of n, however, if the law has any physical basis, ought to be invariable. Actually, we find, different experimenters are not in complete agreement as to what it should be. In the new report, Mr. Dempster Smith provides fresh experimental evidence in confirmation of an earlier result that the value of n is one-eighth. On the other hand, in 1913 Professor Ripper and Mr. Burley, using dry tools, as Mr. Smith does, found n to be one-fifth; Dr. Nicolson ignored the question of durability almost entirely, and Taylor in 1906 presented an index the same as Mr. Smith's, but derived it, we believe, from different experimental methods. Worse still than any mere numerical discrepancy, Mr. E. G. Herbert in 1910 gave results which showed that as the cutting speed was increased, the durability also increased until a speed of 40ft. to 50ft. per minute was reached, and that not until after that point was attained did the durability fall hyperbolically or approximately so. No indication of such a hump in the curve was detected by Professor Ripper. In Mr. Smith's report there is no evidence for or against its existence, for the examination of the "law" connecting speed and durability was not carried below a cutting speed of 60ft. per minute. The various series of investigations thus fail to support each other, and do even contradict one another in a matter of a fundamental kind. In Mr. Smith's case this uncertainty about the index n is particularly to be regretted, for a great deal is built subsequently upon it. Mr. Smith has sought to provide an answer to the very practical question, For a given area of cut, what is the best ratio of depth to traverse to adopt? He finds that the worst cutting performance is given when the ratio has a value of approximately unity, and that the performance is improved about equally for equal departures of the ratio on either side of unity. This interesting result, however, does not command our complete trust, because of the indirect method of its establishment. The procedure adopted was to test the durability of four tools of widely different form, varying the ratio of depth of cut to traverse within the limits allowed by an area of cut amounting to 3/256 square inch. For each tool and each value of the ratio, the cutting speed was chosen such that a duration of about twenty minutes was to be expected under the imposed conditions. How far the expectations were fulfilled, we are not told, but that the various durations did not come out exactly at twenty minutes is implied by the fact that the test results were "corrected" by the $V T^4$ equation, to reduce them all to an exact basis of twenty minutes' life for the tools. It is on these corrected results that Mr. Smith bases his interesting deduction. That a different correcting law might upset the deduction very materially, is obvious. The latitude permissible in this respect is considerable, even though we confine ourselves to a comparison between Mr. Smith's and Professor Ripper's laws, for, transforming from fractional to integral indices, it will be seen that the one involves the eighth and the other the fifth power of the cutting speed.

It has been repeatedly pointed out that in the study of cutting tools, the number of variables entering the problem is so great that correlation between the results of one experimenter and those of another can hardly be made possible, except by close co-operation. In his classical researches, Taylor took account of twelve main variables, some of which comprised a series of minor variables. To hope for comparable results without organising our researches definitely to obtain them, is, in such circumstances, vain. So far, those who have undertaken cutting tool research work have mostly failed to secure correlation of their results with those of previous experimenters. This lack of co-ordination is not confined merely to the selection

of what conditions shall be kept constant, while others are varied, but extends to how the quantities involved are to be measured. Each experimenter, for instance, uses generally a special form or arrangement of machine tool, some of which —as, for example, Mr. E. G. Herbert's tube end-facing testing machine—bear little or no resemblance to practical workshop machines. Again, in connection with the highly important factor of durability of the tool, the widest divergence prevails in the ideas of different investigators as to how it is to be measured. Several workers, such as Mr. Herbert and Professor Ripper, have defined the durability as the time required to produce standard bluntness; but so far as we are aware there has been no agreement among them as to what constitutes standard bluntness, and none whatever as to how it is to be measured. Others, including the late Mr. F. W. Taylor, defined it—obviously very loosely—simply as the time the tool would last without requiring to be re-ground. Yet others, among whom is Mr. Dempster Smith, have taken it to be the time required to break down the cutting edge, an event indicated by the appearance on the work of a narrow planished strip. If in this very fundamental matter we fail to find any measure of agreement, may we expect to find it elsewhere? Lacking such agreement, is it reasonable to anticipate that cutting tool research work will do much to consolidate and extend the facts which have been slowly accumulated by practical experience in the workshop? Pondering these matters, we feel that the time is now ripe for an investigation, experimental and otherwise, aiming at the establishment of an agreed method of undertaking cutting tool research work to the end that the results of all workers in the field may be placed on a comparable basis.

Cast Iron.

IN spite of its admittedly high importance in engineering practice, cast iron still occupies to some extent the place of a metallurgical Cinderella. It is true that a certain amount of research has been devoted to it, and that some important improvements in its production and treatment have been made. A "Cast Iron Research Association" has even been formed. None the less, advance in connection with cast iron has been, and still remains, very slight, as compared with the advances which have been achieved in other branches of metallurgy. Widely as cast iron is employed, it is always regarded as the cheapest of ferrous materials, of which, accordingly, relatively little is to be expected. Even from this point of view, however, there is a great incentive to the ironfounder to seek improved methods, with a view to reducing cost of production. The development of the moulding machine has, of course, helped very materially in this direction, but machine moulding is not specifically confined to ironfounding, although it finds its widest uses in that field. In France, on the other hand, some recent advances have been achieved in the direction of reducing the weight of metal in gates, runners and risers—metal which is necessarily scrap. Whether or not M. Roncerai's efforts will meet with permanent commercial success yet remains to be seen, but his work at least serves to show that in his country a live interest is being taken in the improvement of ironfounding methods.

In Great Britain, now that reviving trade seems likely to bring back activity to the ironfoundries, there are no very strong signs that any great efforts are being made or are likely to be made to improve on existing foundry practice. This is one of those industries, only too numerous in this country, in which the personal skill of the workman is regarded as not only essential to, but sufficient for, success. Scientific control is only rarely applied, probably on the ground that perfectly successful castings are being produced without it, and that, since the material is "cheap," there is no margin for the cost of appliances and staff. The answer is, of course, here as elsewhere, that the application of scientific control leads to cheaper as well as better and more reliable production, and that it is just in the production of a "cheap" material that there can be no room for rule-of-thumb methods. The class of difficulty which may arise even in the mass production of quite simple castings is well illustrated by a case which occurred during the war. A certain type of hand grenade or bomb was to be turned out in enormous numbers, and the castings were called upon to meet two requirements—reasonably good fragmentation when the bomb exploded and reasonably easy machining where the fuse and mechanism had to be inserted. It was quite natural for the then Ministry of Munitions to suppose that every ironfounder in the country could meet such needs. Actually, the mere machining requirement proved a difficulty, until means were provided, first, to inform the founders of the exact content of silicon which was required in such castings, and then to assist them to control the proportion of this element in a proper manner. Possibly war conditions may have had something to do with the difficulty which arose over so simple a matter, but it is surprising, none the less—or would be, if the cast iron industry were on a level in such matters with that which deals with its "bigger sister" product, steel. Yet there is a somewhat analogous difficulty which arises from time to time under modern industrial conditions, quite apart from war. Competition and all that goes with the word "mass production" exerts a pressure upon foundry practice, as upon other branches of industry. The desire is, on the one hand, to produce castings as rapidly as possible with a given plant; on the other hand, the purchasing engineer wants his castings to be easily machined. It is not unknown in works practice incontinently to reject any casting which does not at the first touch come up to the standard of easy machining desired in a particular shop. The founder, naturally, is pressed to make his castings softer, although to some extent that must delay their production a little. None the less, under pressure from the purchaser, the softer castings will be produced, and they will delight the heart of the machine shop worker—particularly if he is on piece-work. But what is the final result? There are, of course, many uses where the very soft casting is quite satisfactory. On the other hand, there are many others where the softer casting is eminently undesirable. For instance, where the casting is exposed to hot gases or steam, the excessively soft cast iron is at a decided disadvantage in resisting corrosion or oxidation. The consequence is that where formerly castings stood well, they now begin to fail after a much shorter period of use. Cases of this kind are not, of course, by any means confined to cast iron; facility of machining has led to the use of unsatisfactory materials, both in steel and brass. The result in all cases, however, is much the same—a very decided and serious reaction upon the whole industry. There can be no better aim for the production engineer to pursue, in this as in other matters, than to lessen the cost of production by every available means, but to produce an inferior article must not be regarded as reducing the cost of production—since the products are not the same. This is an insidious danger which, under pressure of modern competition, it is by no means easy to face and overcome, but it strikes at the root of such industries as those of our country, which depend essentially upon a reputation for quality.

This matter, which we have taken merely as an example, of apparently conflicting requirements, viz., easy machining on the one hand, and closeness of grain and power of resisting corrosive and other destructive influences on the other, serves to suggest that there is very real room and need for advances in the metallurgy of cast iron. For one of the most remarkable features of metallurgical progress, resulting from the co-operation of research with an enterprising industry, is just this very meeting of apparently irreconcilable demands. The power of varying the physical, and even the chemical properties of materials by suitable adjustment of composition and treatment is only just being realised. Not only are we very far indeed from having reached finality, but vast fields are still open, first, for exploration, and then for exploitation. It may well be suggested therefore that investigators, as well as those intimately concerned with the cast iron industry, should not neglect this most important question. There is much need for improvement, and the field is as yet but little explored.

Obituary.

ARTHUR THOMAS WALMISLEY.

WE have to announce with regret the death of Mr. Arthur Thomas Walmisley, which took place at Folkestone on the 18th inst.

Mr. Walmisley, who was the son of the late Mr. Arthur Walmisley, of the Foreign Office, was born in Westminster on April 27th, 1848. He was educated first at King's College School, and subsequently at King's College, London, of which foundation he was afterwards elected a Fellow. He commenced his engineering career as articled pupil to the late Mr. R. M. Ordish, civil engineer, of Great George-street, Westminster. While with Mr. Ordish he assisted in the erection of the great span roof at St. Pancras railway station, considered in its day one of the most remarkable pieces of engineering work in the country. Subsequently he became resident engineer for the Albert Bridge, Chelsea, and then, after being engaged upon some of the drawings for the reconstruction of the Alexandra Palace, Muswell Hill, for which the late Mr. John Johnson was architect, he entered the Westminster firm of Messrs. Edwin Clark, Punchard and Co., being given a position in the drawing-office. While so engaged he served directly under the late Mr. Edwin Clark, who was noted as having been resident engineer under Robert Stephenson on the Britannia and Conway tubular bridges, and who put Mr. Walmisley in charge of the drawing-office when the chief draughtsman went abroad. Later, Mr. Walmisley assisted Mr. Edwin Clark's brother, Mr. Latimer Clark, with designs for floating docks. In 1876 Mr. Walmisley, under the late Sir (then Mr.) A. R. Binnie, was engaged upon the Bradford reservoirs and high-level water supply. A year later he returned to London and started for himself as a civil engineer in private practice in Westminster. He was until 1919 senior partner in the firm of A. T. Walmisley and White.

Amongst notable works on which he was engaged while in private practice were the main roofs of Olympia, Kensington, the roof of the Carlisle Corporation Market, and the reconstruction of the Borough Market, London Bridge. He was also consulting engineer to the Central Markets Committee of the Corporation of the City of London, and executed the Railway-street bridge for the Corporation of Chatham, Blake's bridge over the river Kennet, for the Corporation of Reading. He rebuilt a lock for the Shoreham (Sussex) Harbour Trust, and many other important undertakings. He was well known as an expert witness before Parliamentary Committees, and has rendered services as an arbitrator in many legal cases.

In 1888 Mr. Walmisley was appointed engineer to the Dover Harbour Board, and he held that position until his death. Among the works which he carried out was the widening of the Admiralty Pier. He had attended a meeting of the Board only a few days before his death.

With all who came in contact with him, Mr. Walmisley was highly popular. He was a man of unflagging energy, and his activities covered a wide sphere. He was a Member of the Institution of Civil Engineers, Past President of the Civil and Mechanical Engineers' Society, Past President of the Society of Engineers, Fellow of the Surveyors' Institution, Hon. Associate of the Royal Institute of British Architects, Member of the Geologists' Association, Member of the London Chamber of Commerce, Fellow of the Imperial Institute, Lecturer to the City Guilds' Central Institution (1888), Special Lecturer to the School of Military Engineering (1889), and Lecturer on Waterways, Harbours and Docks at University College for the University of London. He was also the author of "Iron Roofs," "Field Works and Instruments," "Land Surveying and Levelling," and numerous articles and monographs on professional subjects in various publications.

Machine Tools for Locomotive Work

THE paper on the subject named above, which Mr. C. D. Andrew read before the North-Western Branch of the Institution of Mechanical Engineers on Thursday, 18th inst., dealt principally with tools for operations on tires, axles, wheels, cylinders and boilers. With regard to the operation on tires, the author said two distinct types of machine were most frequently employed, one being the duplex lathe and the other the vertical boring and turning mill Although there were still adherents of the horizontal lathe, there was hardly any question of the superiority of the vertical mill for boring and turning. With that type of machine it was practically impossible to cause deformation of the table, as the latter was adequately supported close to the periphery by means of an annular bearing. For boring tires the mill possessed the following advantages:—The tire could be dropped on to the table and the crane liberated immediately for service elsewhere; full use could be made of the tool rams simultaneously; ease of setting the saddles in a position in which they could be allowed to remain with slight adjustment; the tool rams, being in a vertical position, might be readily withdrawn to remove the tires; heavy cuts could be taken, and the operator, looking down on the work, could apply feeds to the tools without changing his position. As regarded rigidity of the tool point and accuracy of alignment of the tools in both vertical and horizontal direction, the vertical mill was preferable to the lathe.

In connection with wheel lathes, Mr. Andrew said the designer was handicapped if he had to provide for heavy cutting on the sides of tires. When profiling on the wheel lathe the tire itself must be gripped rigidly by the chucks or drivers, and that could not be done to the best advantage if the sides had to be machined at the same setting. The ideal method of driving the wheels under cut was by securing the tires rigidly and obviating stresses upon the spokes

and wheel centres due to driving. If side cutting on the wheel lathe was dispensed with, it was quite practicable to secure the tire in such a manner as to prevent both lateral and bending stresses, except such stresses as were produced in the wheels incidentally to the support of the work upon centres. Mr. Andrew described a method which he claimed satisfied the above conditions.

The method of chucking the larger sizes on the boring mill was next considered. Mr. Andrew recommended a three-jaw universal chuck built into the table, presenting a large surface of contact with the tire tread. After the universal chuck was brought into use a further set of three independent chuck jaws was set up for additional security. The serrations of the face of the jaws were in a vertical direction. The tooling of the boring mill must depend upon the capacity of the machine, but as regarded the setting of the tools a useful method was to have a graduated scale upon the cross rail and set the cutting tools with a simple gauge for projection to obtain the correct diameter without trial cuts.

In connection with the work on the wheel lathe the method of calipering the wheels while in process of turning presented a mechanical problem which was easy to solve. A simple method adopted by the author is as follows:—A hardened steel roller running in a swinging arm is dropped upon the tread of the tire of either wheel. The two rollers are so linked together by means of a tube carrier that their respective peripheries are in exactly the same relation radially and tangentially to the axis of the lathe. Therefore, when finishing the thread, if the rollers are dropped upon the surfaces in work, one roller will rotate and the other remain stationary until both are touching the turned surfaces, when the rotation of both rollers indicates to the operator that both diameters are alike.

The author next dealt with the machining of coach and wagon axles, and said there seemed no reason why they should not be both roughed and finished at a cutting speed of 50ft. to 60ft. per minute. That, he said, could be done by giving flexibility to the driving chuck in all radial directions equally, so that instead of the axle forging yielding to the resistance of the chuck the latter was caused to yield freely to the excentricity of the axle about its normal axis. That result had been obtained by the use of a system of driving pins and links which gave the required radial freedom, combined with a positive drive without backlash.

The author described a type of axle lathe sometimes employed in which a scroll former was used to turn the complete profile of the shoulders, journal and wheel seat of the axle, the roller or bowl being linked up to the tool holder, and the profile being reproduced by the tool point. For operations on wheel centres there was a difference of opinion. In America, the author said, it was common to employ the boring and turning mill, but in Europe generally preference was frequently given to a form of duplex lathe.

In the discussion that followed the reading of the paper, Mr. F. W. Reed said that although the author apparently preferred the boring and turning mill to the lathe, there were several points in favour of the latter which gave it a certain advantage over the boring and turning mill. The great rigidity which the author claimed for the boring and turning mill was equally obtainable in a properly designed lathe by making the spindle and face plate sufficiently strong. Mr. Reed was also of the opinion that the work on the lathe was facilitated by the operator being able to look straight at the cutting tools, instead of leaning over the revolving face plate to watch the work proceeding, as in the case of the boring and turning mill. In the lathe, too, the cuttings fell away from the job automatically, instead of piling up on the table as in the mill. Although the lathe was dependent on the overhead crane, which was not necessary in the boring and turning mill, when the tire was put in the lathe it was actually placed on the jaws that would hold it while the various operations were being performed, so that the mill did not gain much in that respect. In the turning and boring mill, the author claimed that setting the saddles could be very easily done, that the arms could be quickly removed, and that heavy cuts could be taken; it was Mr. Reed's opinion that the parallel operations in the lathe could be performed equally efficiently. The model of the drives for locomotive wheels, shown by the author, appeared to be quite good, but it was Mr. Reed's opinion that with serrated drivers there was always a tendency to slip and to cause torsion in the crank axle, which could probably be obviated by the additional use of a stop driver.

With regard to the method of rough setting a tool by a gauge on the rest in conjunction with a scale on the slide rests, that was quite efficient for roughing, but for the final gauging it could not equal diameter gauging which was much more efficient than radius gauging, as any small inaccuracy in the radius was, of course, doubled in the diameter. Mr. Reed did not think the Clements driver allowed of an axle being turned if the axle forging was at all untrue at the centre, even with the improved method shown by the author's model. The double radius tool shown by the author was efficient and was coming into general use, as it facilitated changing from right to left. It was, however, difficult to grind and keep in order. Contrary to the author's statement, Mr. Reed was of the opinion that equal skill was necessary for machining tires on the turning and boring mill as on the lathe. It was important that tools should be quite flat on the rest. The bottom of the tool should be machined, but to prevent slipping due to the smoothness of the tool, it should be filed.

Mr. H. H. Asbridge stated that it was gradually becoming the practice to use grinding for finishing axles, and that process was being adopted exclusively by many railway companies. The time for finishing an ordinary express coach axle—that is grinding both wheel sets and both journals, removing $^1/_{16}$in. from the rough turning—was from 35 to 40 minutes for the complete operation. For a wagon axle it was about 30 minutes. On the Continent locomotive makers were going still further and grinding tires and wheels. Other speakers in the discussion were Mr. Boswell and Mr. C. W. Hunt.

Lloyd's Register Annual Summary.

THE annual summary of the mercantile shipbuilding of the world for the year 1922, prepared by Lloyd's Register of Shipping, has just been published. This summary does not include warships, and it takes into account only merchant vessels of 100 tons gross and upwards, that were launched in 1922, whether they were completed during the year, or are still under construction. Sailing vessels fitted with auxiliary power are included with steamers or motor vessels, according to type of engine. Returns are not available as regards Germany and Austria-Hungary for the war period (1914–18), nor as regards Germany for 1919 and 1920.

GREAT BRITAIN AND IRELAND.

Particulars of Total Output.—It appears that during the year 1922 there were launched in Great Britain and Ireland 235 merchant vessels of 1,031,081 tons (viz., 208 steamers of 950,516 tons, 17 motor vessels of 78,341 tons, and 10 barges of 2224 tons). These vessels were all built of steel. Not a single sailing vessel was launched during the year. The output for 1922 was 506,971 tons lower than the figures for 1921, and represents 41.8 per cent. of the world's output for 1922, as compared with 35.5 per cent. in 1921 and 58 per cent. in 1913. Of the tonnage launched during the year, 762,769 tons are for registration in Great Britain and Ireland, and 268,312 tons (26 per cent. of the total tonnage), are for owners residing abroad.

Size and Type of Vessels.—The returns for 1922 show that 91 vessels of between 5000 and 10,000 tons each and 17 vessels of 10,000 tons and upwards were launched; the following are the largest:—Franconia, 20,000 tons; Conte Verde, 18,000 tons; Doric, 16,300 tons; Mongolia, 15,550 tons; Veendam, 15,434 tons; Volendam, 15,434 tons. Excluding vessels of less than 1000 tons, 42 vessels of about 262,800 tons for the carriage of oil in bulk were launched during 1922. Of these, 34 vessels of about 212,000 tons were built on the Isherwood system of longitudinal framing, besides one other vessel of 6700 tons.

Very few vessels of less than 500 tons were launched in Great Britain and Ireland during 1922, the average tonnage of steamers and motor vessels being thus higher than usual, viz.:—4573 tons; if the vessels of less than 500 tons are excluded, the average is further increased to 5186 tons, as compared with 4602 in 1921, 4387 in 1920, 4006 in 1919, 4593 in 1918, and 4933 in 1917.

Further progress was recorded in the use of steam turbines during 1922, when 50 vessels with a total tonnage of 443,879 tons were launched, which will be fitted with this method of propulsion, and all of them will have geared turbines. It may be stated that all the large vessels mentioned above, and, with the exception of one, all other vessels of 12,000 tons and upwards launched during the year, are to be fitted with turbines. During the year, 17 motor vessels of 78,341 tons were launched, and 9 of them are of 5000 tons and upwards, the largest being of about 9500 tons. The Glasgow district occupied first place amongst the shipbuilding centres, showing an output of 270,639 tons. Then followed Newcastle (240,788 tons), Sunderland (126,713 tons), Greenock (121,429 tons), and Belfast (87,295 tons).

Progress of Shipbuilding During the Year.—As regards the movement of the shipbuilding industry during the course of 1922, Lloyd's Register Quarterly Returns show that at the opening of the year 2,640,319 tons were under construction in Great Britain and Ireland. These figures—the lowest since June, 1919—show a reduction of 1,158,274 tons as compared with the record reached at the end of March, 1921. The Returns issued during 1922 showed a steady decrease quarter by quarter, and the tonnage under construction at the end of 1922, viz.:—1,468,599 tons, is 1,171,720 tons lower than the total in hand at the end of 1921. The total decrease in the tonnage under construction in Great Britain and Ireland during the period of 21 months (March, 1921—December, 1922) amounts to no less than 2,329,994 tons.

But even this great decrease does not sufficiently indicate the actual position of the shipbuilding industry in Great Britain and Ireland. In comparing the present totals with those for normal years, account should be taken of the fact that the total returned as under construction at the opening of 1923 includes about 348,000 tons on which all work is suspended. The only point which may influence favourably any estimate of the immediate future of the shipbuilding industry is the fact that orders for new ships have recently increased.

OTHER COUNTRIES.

Particulars of Total Output.—There were launched abroad during the year, 617 merchant vessels of 1,436,003 tons (434 steamers of 1,265,656 tons, 86 motor vessels of 131,216 tons, and 97 sailing vessels and barges of 39,131 tons). The figures show a decrease of 1,367,624 tons, as compared with those for 1921, and of 4,088,104 tons as compared with 1919—the record year—but are still 35,274 tons higher than those for 1913, during which year the highest pre-war total was reached. The returns for the year include 56 vessels of between 4000 and 6000 tons each; 43 of between 6000 and 8000 tons; 21 of between 8000 and 10,000 tons; and 10 of over 10,000 tons each, including 2 vessels of over 20,000 tons each, the largest being the Columbus of 35,000 tons, launched at Danzig. Excluding vessels of less than 1000 tons, there were launched during the year 54 vessels of a total tonnage of 332,405 tons to be fitted with turbines, the great mahority of which are geared turbines. Of these vessels, 37 are of over 4000 tons each, including 4 of between 10,000 and 15,000 tons, and 1 of about 20,000 tons. The output for the year, abroad, also comprises 18 steamers of about 96,600 tons built on the Isherwood system of longitudinal framing. Including 6 of these vessels of about 40,000 tons, there were launched during the year 19 vessels of about 93,000 tons for the carriage of oil in bulk. During 1922 there were launched 86 vessels of 131,216 tons to be fitted with internal combustion engines. Fourteen of these vessels are of over 4000 tons each, 7 in Germany, 3 each in Denmark and Sweden, and 1 in Norway; the two largest being of 7124 and 7086 tons respectively, built in Denmark. The total figures include a number of sailing vessels fitted with auxiliary power. The tonnage of wood vessels included in thes year's total is 34,454 tons, as compared with 52,193 tons in 1921, and 1,145,582 tons in the war year 1918, when the tonnage of wood vessels launched amounted to 28 per cent. of the total output. Of vessels built of reinforced concrete, only 2 of 4500 tons were launched during 1922. The total figures include a large proportion of barges and other craft which cannot be described as real sailing vessels. Apart from such craft there were launched abroad 58 sailing vessels of 13,892 tons, the largest being 4 vessels of between 400 and 500 tons.

During the year under review 195 vessels of 575,264 tons were launched in German yards. For the purpose of convenience of comparisorr with the output of previous years these figures comprise the 8 vessels of 49,435 tons launched at Danzig—including the Columbus, of 35,000 tons, which is being built by the Schichau firm, the largest vessel launched in the world during 1922. As compared with the output for 1921, the present figures are 66,000 tons higher and represent 40 per cent. of the total output abroad during 1922. Apart from vessels of less than 1000 tons, these figures include 21 vessels of 113,576 tons to be fitted with steam turbines and 12 vessels of 45,513 tons to be fitted with oil engines. The totals comprise 29 vessels of between 4000 and 6000 tons, 20 of between 6000 and 10,000 tons, and 5 vessels of 10,000 tons and upwards, including the Columbus, and a steamer of about 20,000 tons under construction at Hamburg.

The output for the year in France—184,509 tons—was 26,154 tons lower than the total of 1921, but with the exception of that year, is still the highest reached since 1902, which was the previous record year; that total, however, included over 146,000 tons of sailing vessels. The total figures include 4 steamers of between 4000 and 6000 tons, 11 of between 6000 and 10,000 tons, one of 10,741 tons, and one turbine-engined vessel of 13,800 tons. Including the latter, 6 vessels of 57,663 tons will be fitted with steam turbines. The launches included 4 tankers of 28,280 tons.

The total tonnage launched in Holland during 1922—163,132 tons—was 69,000 tons lower than the 1921 figures. As usual, the figures for this country do not include vessels exclusively intended for river navigation. Twelve vessels of between 4000 and 8000 tons each were launched, and 4 of between 8000 and 9200 tons. Excluding vessels of less than 1000 tons, the total figures comprise 12 vessels of about 79,000 tons, to be fitted with steam turbines, including 10 of between 6000 and 9200 tons each.

The output of the United States for the year 1922, namely, 119,138 tons, was 887,275 tons lower than during 1921, and nearly 4 million tons less as compared with the record year of 1919. It is the lowest since 1897, and it only represents 8.3 per cent. of the total output abroad for the year 1922. The total figures, however, include 1 steamer of about 12,000 tons launched at San Francisco, and the Japanese twin-screw steamer Kamoi of 10,222 tons, launched at Camden, N.J., for which vessel the turbo-electric method of propulsion has been adopted.

The total figures for Italy—101,177 tons—were 63,571 tons lower than those for 1921. About 65 per cent. of the total represents the output of the Trieste district. The totals comprise 14 steamers of between 5500 and 6700 tons each. Three vessels of 15,193 tons are built to carry oil in bulk.

The output for Japan—83,419 tons—was 144,000 tons less than in 1921, a reduction of over 63 per cent. As compared, however, with pre-war years the present output still exceeds the figures for any year prior to 1914. The 1922 totals comprise 6 vessels of between 4000 and 8000 tons each, and one turbine-engined vessel of 10,413 tons. These figures include 4 vessels of 21,363 tons which will be fitted with steam turbines, and 2 merchant vessels of 12,515 tons built for carrying oil in bulk.

The total tonnage launched in all the British Dominions overseas during 1922, namely, 62,765 tons, was about 67,000 tons less than in 1921. The tonnage launched in Canada—17,012 tons—was less than one quarter of the output in 1921. Only one large vessel is included, viz.:—a lake steamer of 7403 tons, built at Port Arthur, Ont. The tonnage launched in the other British Dominions was 45,753 tons, and included 25,048 tons launched in the Hong Kong district, and 14,998 tons in Australia. The totals for Hong Kong comprise 2 vessels of about 5800 tons each and one of 8030 tons.

The total tonnage launched in Denmark, Norway and Sweden amounted to 103,445 tons, which was 91,000 tons lower than the output for 1921. The decrease in Denmark amounted to 36,222 tons, in Sweden to 35,873 tons, and in Norway to 19,067 tons. The total figures include 2 motor vessels of between 7000 and 7125 tons each launched in Denmark, 3 in Sweden of between 5000 and 5630 tons each, and 1 in Norway of 4920 tons. The total tonnage of the steel vessels fitted with internal combustion engines launched in these countries during 1922—56,431 tons—is higher than that of any country outside Great Britain.

Transporter for Ireland.

THE transporter which we illustrate by the line drawings herewith and the half-tone engravings on page 94 is noteworthy on account of the somewhat unusual conditions it has been designed to comply with. It has been made by Stothert and Pitt, Limited, of Bath, and is being installed at the factory of Henry Ford and Son at Cork, where it will work on the quayside. The intention is to unload coke and pig iron from ships lying alongside, and to convey them over several intervening buildings to the foundry behind. It may, however, be necessary to dump the material in the foreground, and it would then, of course, not be necessary to raise the grab to so great a height. The result is that a very high open portal has been provided between the towers of the gantry, so that the load need not be raised, to clear the bracing, higher than its ultimate destination. The loads to be dealt with will be either coke, coal or pig iron. The former will be handled by a grab, while the pig iron will be picked up by a magnet.

The general scheme of the transporter is, as will be seen from the drawings, one comprising two cantilevers supported by a tall tower; but as the waterside cantilever must be luffed up to clear the rigging of ships lying alongside, the anchor ties of the two cantilevers are distinct. When in the working position the outboard arm of the transporter is supported entirely by the two heavy chain stays that form a rather prominent feature of the photographic illustrations, and no weight is taken by the luffing tackle These chains may, at first sight, appear rather massive, and that is certainly the impression we gathered when inspecting the transporter, but it should be borne in mind that the total weight at the end of the cantilever, with a full load, is as much as 13 tons. The inshore arm of the cantilever is naturally fixed in elevation, and the distance from the ground to the transporter rails is some 60ft. The outreach of the crab over the water is 66ft., and over the land side 54ft. 9in.

The great height of portal, already referred to, has involved careful consideration in the design of the tower, and the legs are very thoroughly braced in one direction, as will be seen from the longitudinal elevation—Fig. 1. Transversely to the line of the transporter, however, the legs must be unstayed for a considerable height, and it is thus important that they should be symmetrically loaded. For this reason the two main verticals of each leg are brought together to a point at the top, and each pair is connected together by a stiff transverse truss standing on the apices of the legs. The cantilever girders are hung from these trusses, and above them are built up the towers for carrying the cantilever ties. All the vertical reactions are thus brought directly to the top points of the legs, and excentric loading, which might tend to cause the legs to buckle, is avoided. There is ample clearance under the

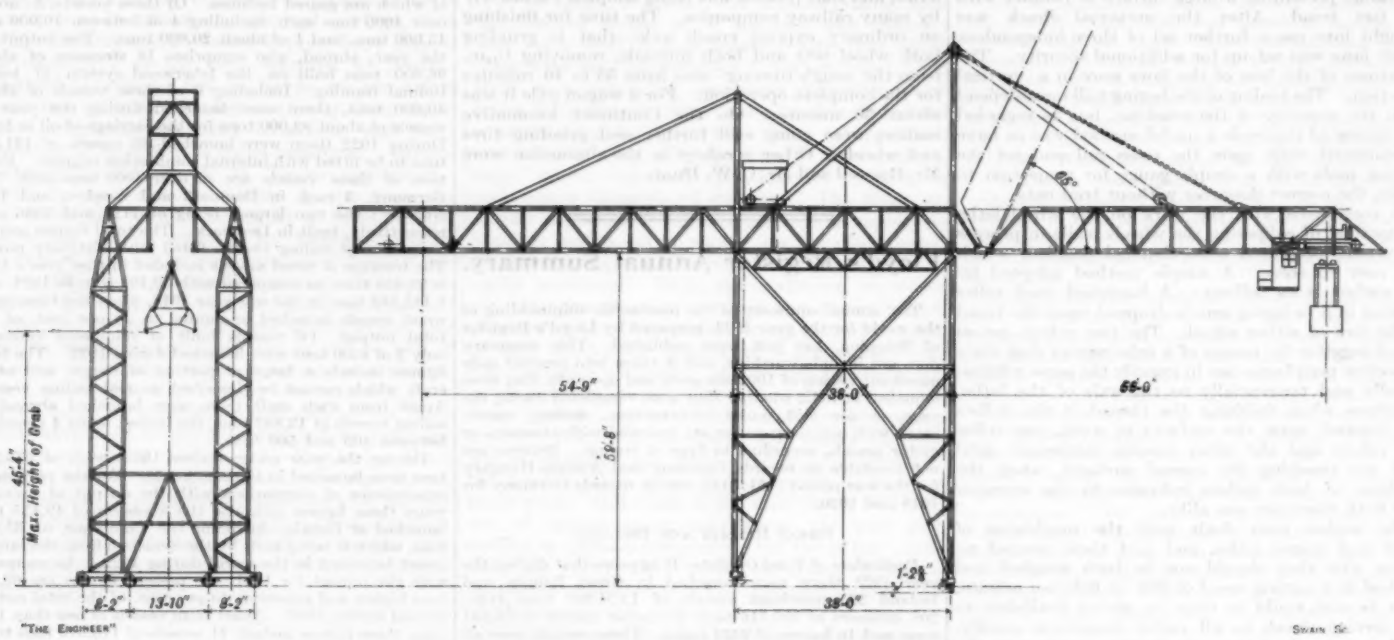
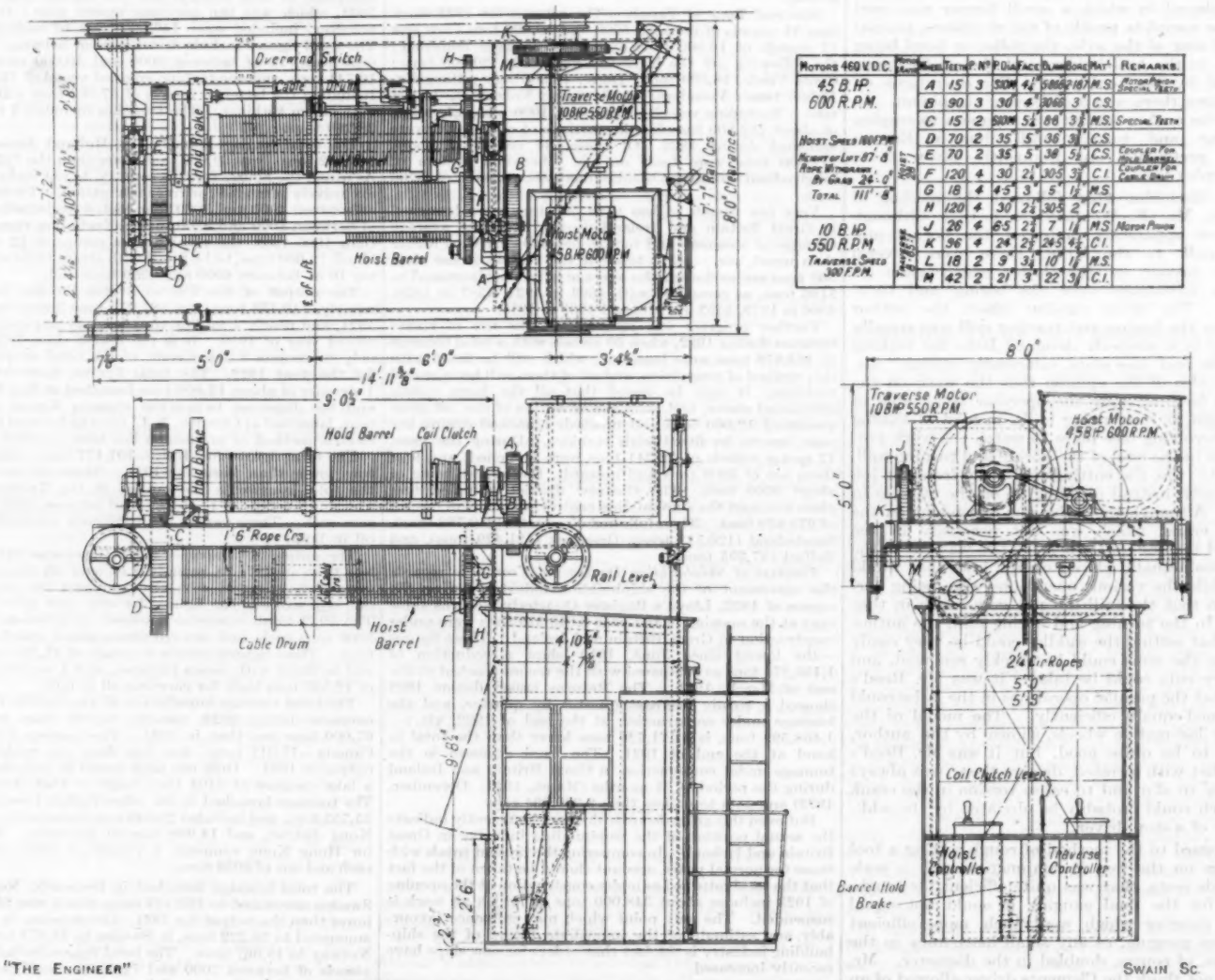


FIG. 1—END AND SIDE ELEVATIONS OF 5-TON TRANSPORTER



MOTORS 460 V D.C.	PINION SHAFT	WHEEL	TEETH	P.	No.	DIA.	FACE	DIA.	BORE	MAT'L	REMARKS
45 B.HP. 600 R.P.M.	HOIST	A	15	3	30DP	4¼"	5.066	1⅛	M.S.	MOTOR PINION SPECIAL TEETH	
		B	90	3	30	4"	30.66	3"	C.S.		
		C	15	2	30DP	5¼	8.66	3⅛	M.S.	SPECIAL TEETH	
HOIST SPEED 100 F.P.M.		D	70	2	35	5"	36	3⅛	C.S.		
HEIGHT OF LIFT 67'-6"		E	70	2	35	5"	36	5¼	C.S.	COUPLED FOR HOIST BARREL	
ROPE WITHDRAWN BY GRAB 24'-0"		F	120	4	30	2¼	30.5	3⅛	C.I.	COUPLED FOR CABLE DRUM	
TOTAL 111'-6"		G	18	4	4.5	3"	5"	1½	M.S.		
		H	120	4	30	2½	30.5	2"	C.I.		
10 B.HP. 550 R.P.M. TRAVERSE SPEED 300 F.P.M.	TRAVERSE PINION SHAFT	J	26	4	6.5	2½	7"	1"	M.S.	MOTOR PINION	
		K	96	4	24	2½	24.5	4½	C.I.		
		L	18	2	9"	3½	10"	1½	M.S.		
		M	42	2	21	3"	22	3⅛	C.I.		

FIG. 2—ARRANGEMENT OF HOISTING BARRELS AND CABLE DRUM ON THE CRAB

longitudinal bracing of the tower, and as the tracks on which the structure runs are 38ft. apart, there is accommodation for several lines of railway, or the space between the tracks may be used for piling a considerable stock of material. On account of the contour of the land the track nearer to the waterside is 1ft. 2½in. below that behind. The whole structure is travelled along the tracks by means of a motor in the house above the transporter girder. This motor is also used for luffing the outboard cantilever. Fig. 4 shows the gearing for connecting the motor with the two luffing barrels and, alternatively, with the mitre wheels driving the travelling gear. The motor is of 10 horse-power, and runs at 550 revolutions per minute. It will travel the machine along the rails at a speed of 30ft. per minute, and will luff up the cantilever to the full extent in three minutes.

The crab—see Fig. 2—which has a total travel of 158ft. 9in., is mounted on four wheels 1ft. 6in. diameter, that run on the bottom boom of the transporter bridge. It has to deal with the following materials:—Coke, weighing about 1 ton, in a 75–93 cubic feet capacity grab, weighing about 2¾ tons; pig iron, weighing about 1¼ tons, lifted by an electromagnet. The crab is provided with one barrel for the two hoisting ropes, one barrel for the two holding ropes for the grab, and one barrel for coiling the electric cable when using the magnet. The holding barrel is operated by a coil clutch, and the cable drum by a pinion attached to a radial arm, centred on the drum axis, which is always in gear with a spur on the drum shaft, and made to gear also with a spur on the hoist barrel when the magnet is in use. The hoist and cross traverse motors are each provided with solenoid brakes, and the motors are covered with sheet steel houses. The crab is provided with limit switches to limit the motion of the cross traverse in each direction. An overwind switch is also provided, and is operated by a travelling nut. The operator travels with the crab in a timber-covered cage provided with a door and windows. The operator has to leave his cage and go to the house over the bridge when it is necessary to use the travelling or luffing machinery.

The hoisting motor is of 45 brake horse-power, and runs at 600 revolutions per minute, while the cross traverse motor is similar to that used for travelling and luffing. The electricity supply is direct current at 460 volts. The crab is capable of hoisting the full load at a speed of 100ft. per minute and traversing at 300ft. per minute. The hook can be lowered to 40ft. below rail level.

The grab, which has a capacity of 3 cubic yards and is shown in Figs. 3 and 5, is controlled by four wire ropes, each 2¼in. in circumference. The main lifting ropes of the crane are connected directly with the closing barrel of the grab, which, being of large diameter, coils the ropes with a minimum of friction, thus ensuring a prolonged life for the wire ropes and a high grab efficiency when digging. The holding or opening ropes are attached by shackles at the head of the grab to an equalising beam. The purchase gear, it will be seen, is carried by steel links above the hinge centre of the halves of the bucket, and is thus kept well up above the material to be grabbed, which allows the full weight of the grab to be borne on the cutting edges or lips of the bucket and also enables the grab to sink well into the material. This feature naturally adds greatly to the digging power and general efficiency; also, when the grab is closed, it provides ample clear space for heaping. The bucket is constructed of mild steel plates and angles well stiffened with doubling plates. The lips and cutting edges are well chamfered. The hinge plates are extended beyond the hinge itself and cut away diagonally—as seen in Fig. 5—so that when the grab is either opened or closed a crevice is formed between the sloping edges of the plates that nips the ends of the barrel spindle and supports the purchase gear in a vertical position. The rods which support the head gear are of mild steel securely braced together and are fitted with steel bushes to take the pins which connect them with the bucket. The four ropes are attached to the grab in a simple manner, so that they can be easily detached and connected with a lifting beam which carries a hook for lifting ordinary loads up to 5 tons.

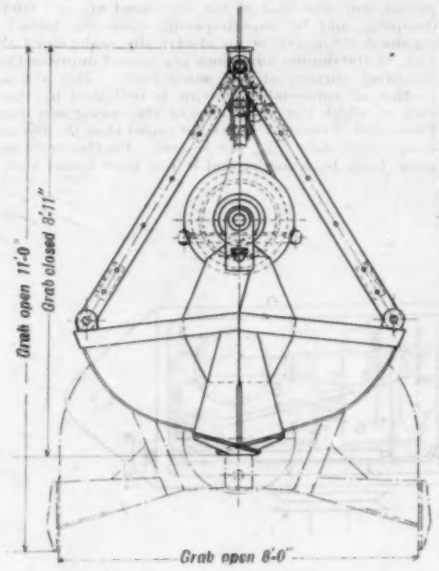
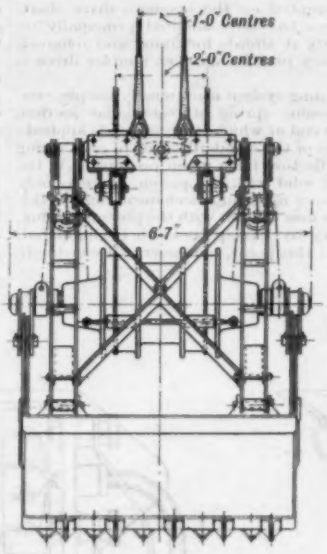


FIG. 3—THE BUCKET GRAB



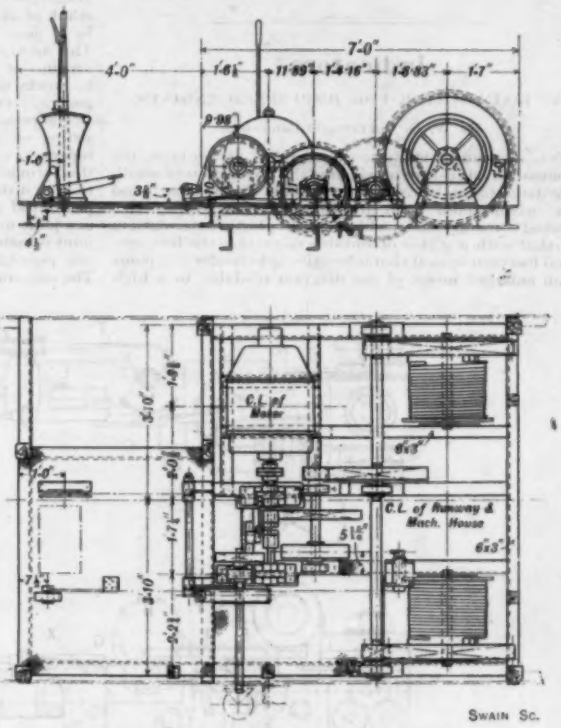


FIG. 4—GEAR FOR LUFFING AND TRAVELLING

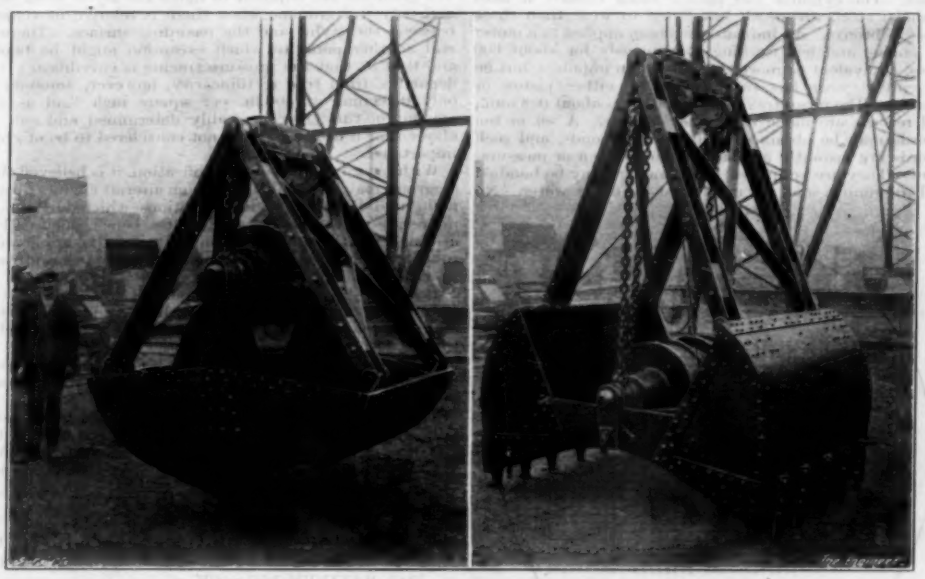


FIG. 5—THE BUCKET GRAB IN CLOSED AND OPEN POSITIONS

TRAFFIC PROBLEMS IN BUENOS AIRES.

WITH a steadily growing population and a constant increase in the number of motor cars and tramcars congesting the narrow streets, the traffic problem of Buenos Aires daily gets worse and worse. The City Council has spent millions of pesos in the construction of new diagonal avenues, and the widening of some of the busiest streets. A subway, carrying double tracks for the fast services of the Anglo-Argentine Tramway Company, runs from east to west of the city, but these several attempts to make good the original deficiencies of the narrow Spanish lanes in a great metropolis that has grown out of all knowledge have still left the problem as acute as ever it was. In the opinion of experts the only solution is to build, not one, but a dozen subterranean traffic routes, similar to that which now runs under the Avenida de Mayo. The Anglo-Argentine Tramway Company is directly interested in such a scheme for the reason that, as conditions are to-day, it is practically impossible to maintain the street services in the state of efficiency desired, and because it is daily becoming imperative to relieve the surface lines of much of the traffic they should never have been expected to carry. The general manager of the company has had an interview on the question with the Lord Mayor of Buenos Aires and outlined a scheme for the construction of a new subway from north to south in a line right through the centre of the city. This subway would connect the three terminal stations of the British railway companies at Retiro, with the Plaza Constitucion terminus of the Great Southern Railway, another British enterprise, and continuing, by passing under the Riachuelo River, emerge at Avellaneda. This underground route would be about five miles long under the very busiest part of Buenos Aires, and if adapted for motor traffic as well as tramways would undoubtedly relieve a good deal of the present congestion. No details of the scheme or estimates of the cost have been announced, but the work, while it will present no great engineering problem, will certainly involve the expenditure of at least 20,000,000 dollars. The Lord Mayor is interested in the project and will again confer with the tramway company's manager and other experts, in order to arrive at a definite idea of the scheme and decide how the construction, if authorised, can be financed.

AUSTRALIAN ENGINEERING NOTES.

THE Victorian Railways Department is completing construction of its first electric locomotive. The engine will consist of two units, which will be capable of exerting a combined tractive force of 37,000 lb. at 15 miles an hour, slightly in excess of the power of the "C" type of locomotive, which is the most powerful at present in use in the State. The electric locomotive will be used principally for service in the metropolitan goods yards and for hauling suburban goods trains.

* * * * * *

THE New South Wales Legislative Council, before passing the Sydney Harbour Bridge Bill, rejected by 40 votes to 7 an amendment proposing the exclusive use of Australian materials in the construction of the bridge.

* * * * * *

THERE is every likelihood of the South Australian Government calling for tenders shortly for a number of locomotives for the Hills Railway outside Adelaide. The Railways Commissioner has stated that there will be no difficulty in securing engines capable of hauling nearly four times the load which engines of the type now in use can deal with. The State Treasurer has announced that plans for the projected locomotive can be purchased in

America, and that it is possible the Government will call for tenders at an early date.

* * * * * *

SPEAKING at Zeehan, Tasmania, in which district his firm possesses iron ore properties, Mr. C. H. Hoskins, managing director of the Hoskins Iron and Steel Company, Sydney, said that his firm had obtained 500 acres of land at Port Kembla, N.S.W., on which to erect blast-furnaces. As soon as work was commenced at Port Kembla the company, he added, would develop its mining lands around Zeehan.

Indicators.*

MICRO-INDICATOR FOR HIGH-SPEED ENGINES.

By W. G. COLLINS, of Cambridge.

THIS instrument is of the cylinder and piston type, the principal novel feature of which is the production of small-scale diagrams on transparent celluloid. It has been found that, when acted upon by the recording stylus, this material is readily susceptible to slight plastic deformation, and that with a stylus of suitable formation the line produced has such optical characteristics as to render any point on an enlarged image of the diagram readable to a high order of accuracy. The diagrammatic drawing, Fig. 1, shows the construction of the micro-indicator. A is the cylinder liner of hard stainless steel, working in which is the piston B. This liner is readily removable and may be replaced by liners of smaller area, thus rendering the instrument suitable for extra high pressures. The piston-rod C, which is formed solid with the piston, is kept in firm contact with the pressure spring E by means of the subsidiary spring D, the spring E being bolted firmly to the rigid frame V. Attached to the pressure spring is a light arm F carrying the recording stylus G. This stylus produces records near the edge of the celluloid disc H, which is carried on, and bent to conform with, the surface of the segment of a cylinder M, and is held in position by means of clips and a pin passing through its centre, the cylinder M being given a reciprocating motion about its axis through the light steel tape T, passing over the adjustable guide pulley N, the other end of this tape being connected to a crank, or other suitable mechanism driven at engine speed, which will give the periphery of the drum M a travel of about 3 mm. The lower screwed portion U is intended to connect directly to the cylinder of the engine under test. These are the *essential* parts of the indicator, and the action of forming a micro-diagram will be perfectly clear.

There are, however, a number of adjuncts which add greatly to the convenience of its use, the principal accessory being an automatic switch, Fig. 2, the purpose of which is to control the recording stylus so that it only remains in contact with the recording surface for one complete engine cycle. This switch carries an axle 2, on which is formed a worm, the axle being driven by means of a light round belt from any convenient portion of the engine, such as the fan or dynamo pulley, and should run at approximately engine speed. The actions of the switch and indicator are as follows :—

On depressing the Bowden wire control push W the celluloid disc H is rotated one-tenth revolution, thus bringing a fresh recording surface into position. At the same time a circuit is closed by means of the key X through the electro-magnet 3 in the automatic switch. This magnet actuates a simple form of escapement 4, which allows the spring-controlled pivoted arm 5 to come into such a position that when pressure on the knob of the Bowden wire is released and the magnet 3 is demagnetised, a pin on the arm 5 engages with the worm, drawing the arm over, the action of which is to operate the key 6 which closes the circuit through the electro-magnet Y, Fig. 1, on the indicator, thus attracting the armature K and bringing the stylus G against the face of the celluloid disc H. The stylus is held in position for one cycle only, the arm 5 having been carried along by the worm until the key 6 re-

* Institution of Mechanical Engineers—symposium of papers on "Indicators."

opens, after which the arm returns to its original position. The milled head screw 7 is for the purpose of adjusting the time of closure of the key 6, and this allows the worm axle to be driven at speeds greater or less than engine speed. The screw Z serves to adjust the travel of the stylus and its pressure on the record disc.

For motor car work the indicator may be clipped on to a sparking plug, which has a hole in its side, this hole communicating with both engine and indicator cylinders. This method of fixing forms a convenient and simple means of connection with the combustion chamber of the engine. The light steel tape which conveys reciprocating motion to the recording disc carrier can be connected to a crank of about 3 mm. throw, the shaft of which is driven by a gear wheel mounted on the magneto drive shaft. This method of drive has been adopted principally on account of the facility it affords for fixing and removal. In works or laboratory practice an even simpler drive is generally possible.

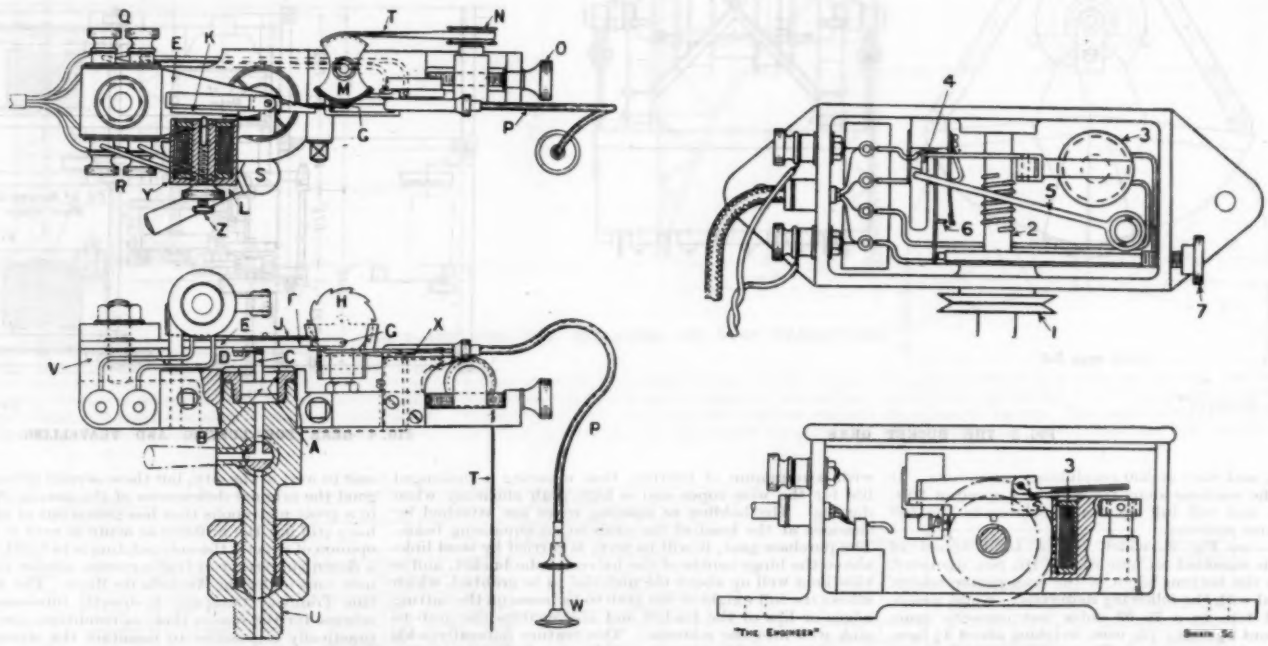
The pressure recording system is extremely simple, consisting of a flat pressure spring of rectangular section, tapering towards the end at which the pressure is applied ; this form also permits of the standardisation of each spring to give a definite deflection for a given pressure. As the piston-rod is formed solid with the piston, there is only one joint in the pressure recording mechanism, and as this joint is maintained in firm contact with the pressure spring, any possible tendency to develop backlash is eliminated. The movement about this point, moreover, is exceedingly small. The cylinder and piston, being formed of hard stainless steel, are much less liable to wear than those made of bronze. An indicator has been applied to a motor car engine and left working continuously for about 600 miles, equivalent to more than a million impulses, but no perceptible wear has taken place on either piston or cylinder. The mean travel of the piston is about 0.8 mm., and records are made with great facility. A set of ten records may be obtained in as many seconds, and such records are instantly available for inspection or measurement. They are permanent in character, may be handled with impunity, and are unaffected by oil or water. No photography is necessary, as by means of a specially designed microscope fitted with a graticule, not only can the diagrams be examined, but pressures read and the M.E.P. calculated. Should enlarged records be required they may be obtained by a *camera lucida*, by projection on a screen and tracing, or by photographically enlarging. For examining the records a special form of microscope has been designed which is light and portable, and which is arranged with a swinging arm to carry the disc of records, which permits any one of them to be brought into the field of view. A screw is provided for the purpose of bringing the base of the diagram into coincidence with the zero line of the graticule ; the appearance of a curve, as viewed through the microscope, is then as shown in Fig. 3.

The question has been raised as to the effect of road vibrations on the correctness of diagrams obtained on a car due to possible deflections of the indicator spring. It may be well, therefore, to point out that, for most purposes the area of the indicator piston is 0.25 square inch, that a pressure of 0.5 lb. is required to deflect the 500 lb. spring 0.01 mm., and that the total weight of the moving system is but a few grammes. No externally applied vertical acceleration which is likely to occur in practice can therefore deflect the spring by a measurable amount. The effect of the friction of the stylus on the celluloid disc may also be considered as a possible source of error. That the amount of friction from this is very small can be shown by setting a 500 lb. indicator spring with its piston into vibration with its stylus in contact with the celluloid recording surface, thus giving a record of, not only its free period, but also that of the combined air and frictional damping, and by superimposing upon the record thus obtained the curve of an electrically maintained tuning fork, of 100 double vibrations per second impressed on the recording surface at the same time. The absence of friction of appreciable amount is indicated by the slow rate at which the vibrations of the spring are damped. From such a record it has been found that the free period is approximately $^1/_{1200}$ per second. Further tests on this point have been made, and it has been found that only 1.5 grammes are required to move the stylus from rest, and only 0.6 gramme when there is relative movement between the stylus and the recording surface. There is still another point to which exception might be taken, and that is, that the pressure tracing is curvilinear ; the departure from true rectilinearity, however, amounts to only 0.08 mm. at 400 lb. per square inch, and as the amount of this error is readily determined and can be allowed for if necessary, it is not considered to be of great importance.

With regard to the field of application, it is believed that diagrams may be readily taken from aircraft engines during flight and therefore under conditions which are almost impossible of attainment on the test bench, such as low atmospheric pressure and temperature. Its application to motor car engines under running conditions has already been mentioned.

It is believed also that, on account of its simplicity, the waterproof qualities of the recording medium and the ability to take diagrams from a distance it would be useful to the locomotive engineer, as the diagrams may be obtained by pressing a button in the cab, thus avoiding the somewhat hazardous processes connected with the use of most other forms of indicator.

Thanks are due to the Cambridge and Paul Instrument Company for the facilities it has given the author for the development of the apparatus described, and to Mr. W. J. Stallan, who is principally responsible for the design of the automatic switch.



FIGS. 1 AND 2—DIAGRAMMATIC DRAWINGS OF COLLINS' MICRO-INDICATOR AND AUTOMATIC SWITCH

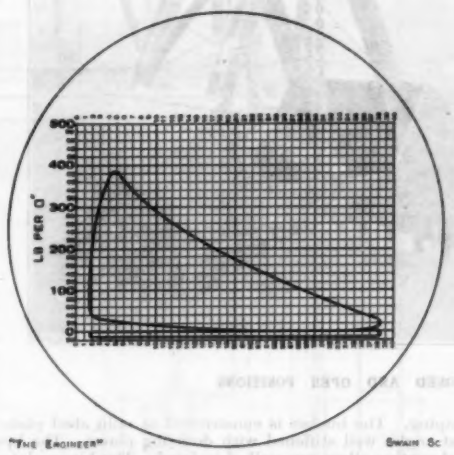


FIG. 3—DIAGRAM AS VIEWED THROUGH THE MICROSCOPE

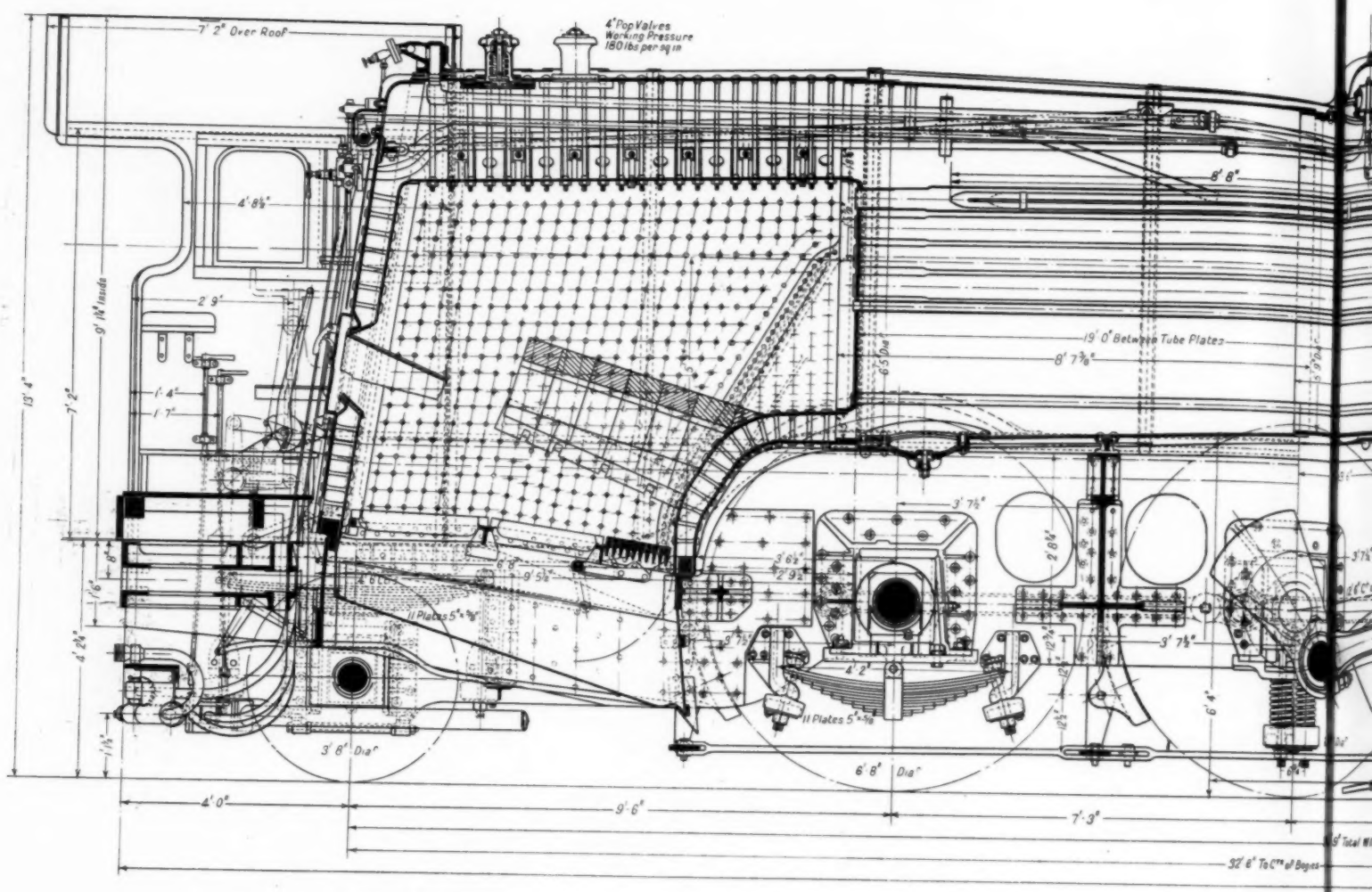
R.A.E. ELECTRICAL INDICATOR FOR HIGH-SPEED INTERNAL COMBUSTION ENGINES, AND GAUGE FOR MAXIMUM PRESSURES.

By HARRY WOOD, Engine Research Section, R.A.E., Associate Member. Presented by W. SYDNEY SMITH, Superintendent, R.A.E., S. Farnborough.

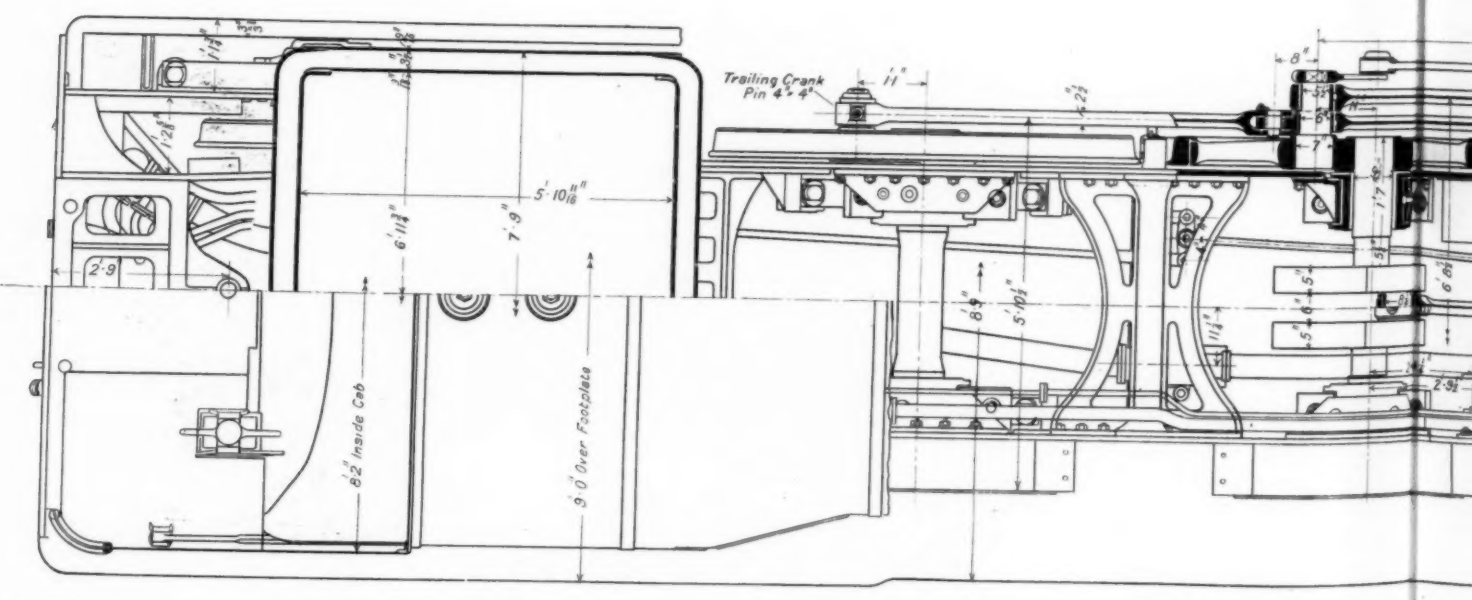
The Royal Aircraft Establishment electrical indicator is of the "balanced" type ; that is to say, the varying cylinder pressures are not recorded directly, but the time is noted at which the pressure in the cylinder just "balances" some standard pressure. By gradually increasing this standard pressure a set of time records is obtained which comprises the whole range of engine pressures, although each pair of records belongs to a different engine cycle. In the R.A.E. indicator a complete pressure record on a time basis can be taken in less than ten seconds. With the engine speed at 1500 revolutions per minute this corresponds to 125 engine cycles. It should be noted that in general there will be two points of balance in each cycle for any given pressure, one during the compression and explosion stroke when the pressure is rising,

GREAT NORTHERN RAILWAY—THREE-CYLIN

MR. H. N. GRESLEY, M. INST.



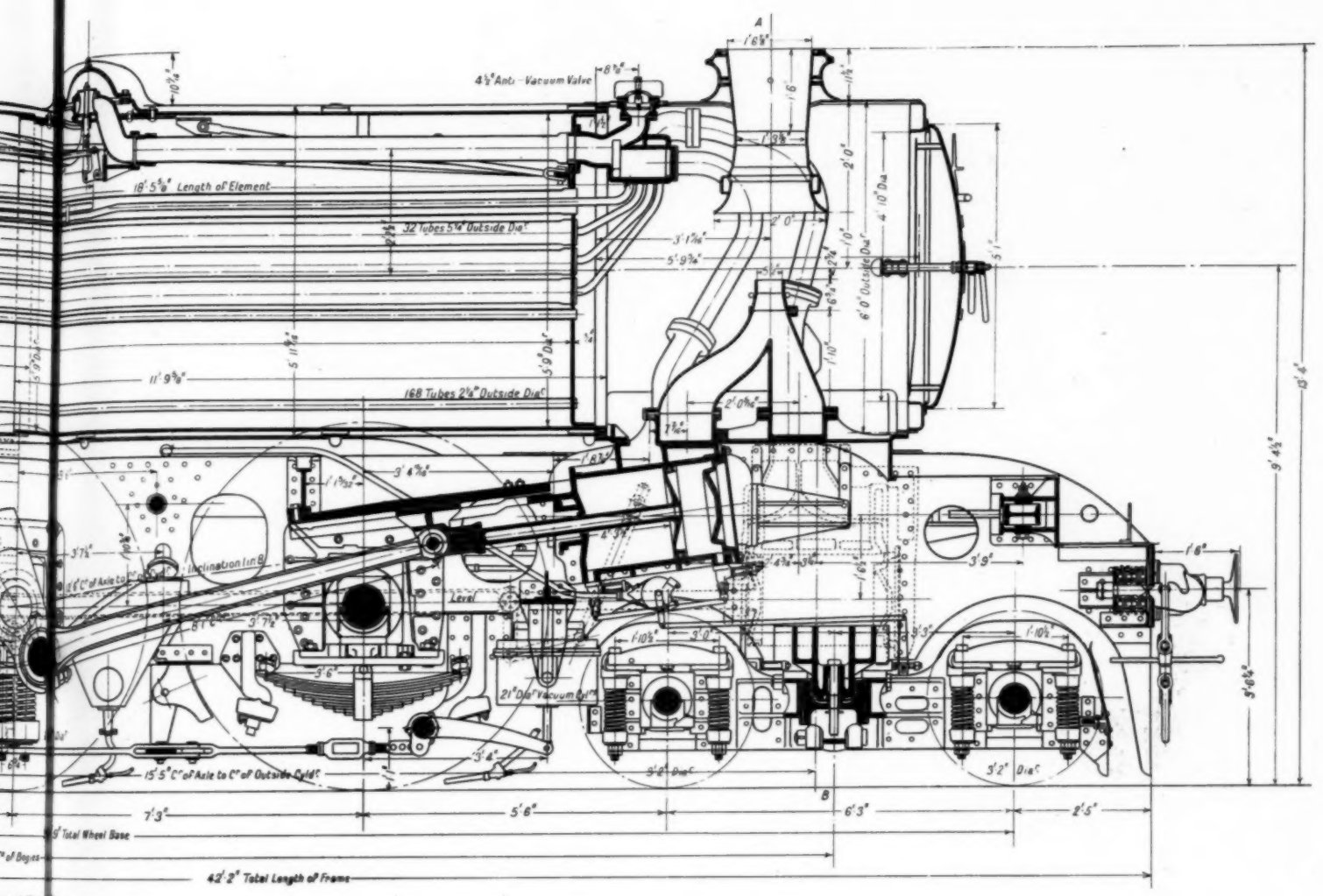
Sectional Elevation

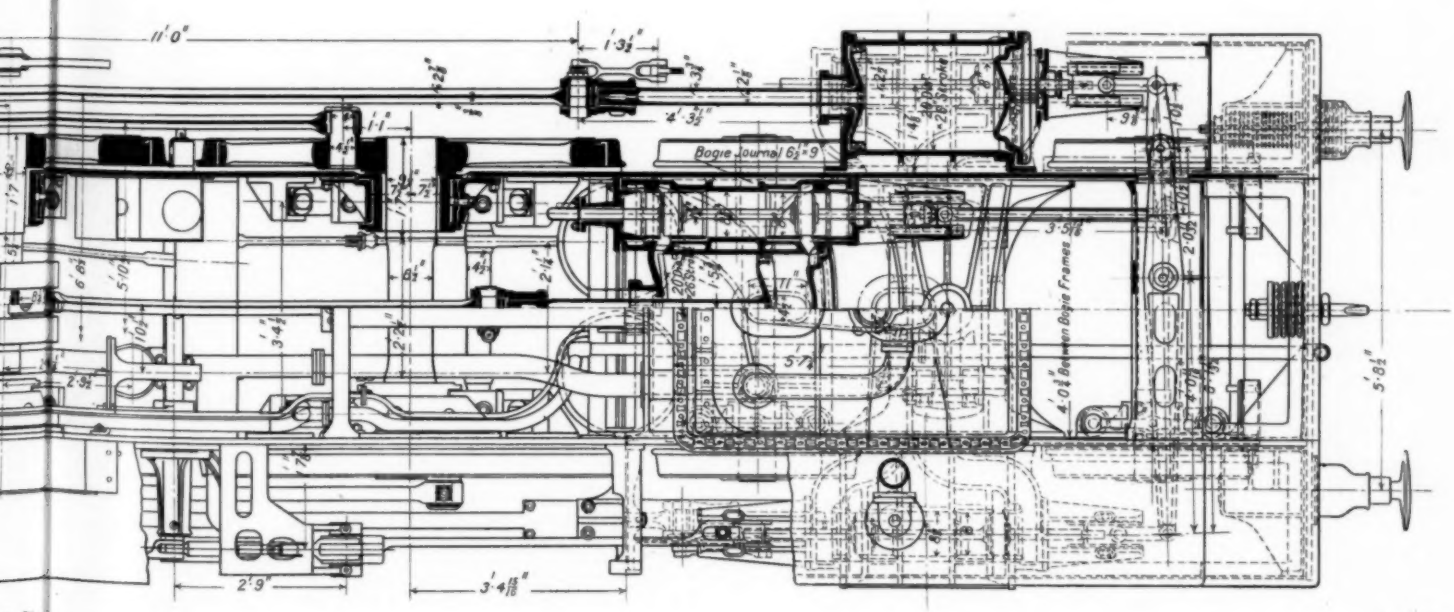


Sectional Plan

...YLINDER "PACIFIC" TYPE PASSENGER ENGINE

...M. INST. C.E. DONCASTER, ENGINEER





SWAIN Sc.

and one during the expansion stroke when it is falling. The time interval between these two pressures will be the shorter the nearer maximum pressure is reached, *i.e.*, the nearer we approach the "peak" of the diagram. In order to obtain a record of the expansion pressures near the "peak," the recording device has to be very quick acting.

In the R.A.E. indicator the balance point is obtained by the engine pressure just lifting a small valve loaded with a known air pressure. The moment of lift is recorded by the breaking of an electric circuit, of which the valve forms part. The breaking of the circuit causes a spark, which perforates a sheet of paper on a rotating drum running at half engine speed. The sparking point moves relatively slowly from one end of the drum to the other. In the example quoted the drum makes 125 revolutions whilst the sparking point moves once across its face. The sparking point is attached to a piston in the indicator cylinder, which is driven forward by air pressure against the resistance of springs. If it were replaced by a pencil, a helix of 125 turns, every point on which would correspond to a different pressure, would be drawn upon the paper. Now the balancing pressure on the valve already mentioned is the same as the pressure in the indicating cylinder, for both are coupled to the same air supply. Hence the instant at which sparking occurs will always coincide with a definite position of the sparking point, and since the rotations of the drum correspond with those of the engine, the sparking will take place at fixed positions on the drum. The whole action may now be followed. Consider what happens for a few cycles. Air pressure is admitted to the indicator cylinder and to the balanced valve. It has reached already, let us say, 50 lb. per square inch, and the sparking point is opposite that position on the drum. As soon as the compression pressure amounts to 50 lb., the valve is driven off its seat, a spark occurs, and the paper on the drum is punctured. The pressure in the engine cylinder continues to rise and then falls. At the instant it descends to 50 lb. the valve is driven on to the seat again by the air pressure, and another spark passes. But since in the interval the drum has made a portion of a revolution, the paper is punctured at a different place. On the next revolution of the drum the air pressure has risen to, say, 60 lb. The sparking point is opposite to the corresponding portion of the drum, and two dots are obtained as before, one made as the pressure rises in the engine cylinder to 60 lb., and the other as it falls again to that figure. And so on for each compression and expansion stroke. One point on each is obtained for each revolution of the drum, and a diagram as shown in Fig. 4 is obtained and is readily reduced to the familiar form.

Pressure Scale 240 lb. per square inch = 1 inch. Austro-Daimler 6-Cylinder Water-Cooled Engine.

180 mm. Bore. 180 mm. Stroke. Ratio = 5·59/1. Max. Pressure = 630 lb. per square inch gauge.
Speed = 1,100 R.P.M.

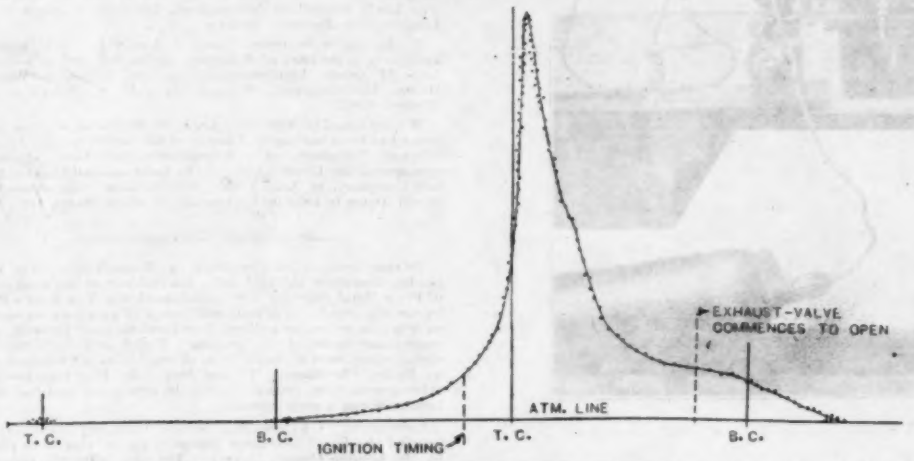


FIG. 4—TYPICAL DIAGRAM FROM R.A.E. INDICATOR

Description of Indicator.—The balance valve is shown in Fig. 5. It consists of a light disc A, floating between two faces and guided by a spindle electrically insulated from the rest of the body. One side of the disc is connected through a tapered cock B to the combustion space of the engine, and the other side of the disc to a source of high pressure air C. The spindle guiding the disc is connected to the primary circuit of a coil, and the two faces between which it floats form the earth of this circuit. Consequently the disc acts as a contact breaker for this electrical circuit. The range of the movement of the disc is limited to about 0.03in.

The recording mechanism is shown in Fig. 6. Here A is the indicator drum and B the indicator cylinder. The drum is 12in. in circumference and 9in. long; it is driven through a positive clutch with one dog only, in order that its phase in relation to the crank shaft may be invariable. It is normally at rest, the drive being taken on an idle shaft, which is engaged first by a cone clutch, which, when the drum is rotating at the same speed as the idle shaft, is disengaged and the positive clutch brought into engagement. Paper is wrapped round the drum and is secured by inserting the ends through a slot into a space between two sectors of a small shaft running the length of the drum. One of these sectors can be rotated to tighten the paper on the drum and jamb the two ends of the paper between the faces of the sectors. The outside end of the indicator piston carries a light link connected to a parallel multiplying motion, the last link of which terminates in a spark point guided so that it moves parallel to the axis of the drum and at a constant distance from its surface. The other extremity of the link carrying the sparking point is constrained to move in a straight line perpendicular to the axis of the drum; its guide is connected to the high-tension terminal of an induction coil in such a manner that the link is at high potential throughout its length, the remainder of the linkage being insulated from it. The guide at the spark point end of the link is also insulated from the remainder of the instrument. The movement of the spark point is 7.8 times that of the piston. A combination of four springs is used to control the movement of the piston—two main tension springs and two light back-to-back compression springs concentric with the cylinder. For taking a complete diagram all four springs are used, but for a light spring diagram the two main springs are disconnected, the sparking point then taking up a new zero position about halfway down the drum and enabling suction pressures as well as positive pressures up to about 20 lb. per square inch to be recorded.

The drum shaft is driven usually at half crank shaft speed by a chain and suitable sprocket wheels. Considerable care is taken to eliminate backlash by fitting a jockey pulley to the chain and a brake on the drum shaft, the latter being engaged while taking the record. The diagram is synchronised by throwing the drum into engagement with the brake on and slowly turning the engine until the piston of the cylinder being recorded is on its top centre of compression stroke. A line is then scribed on the drum immediately opposite the spark point, and this line is transferred to the paper on which the diagram has been obtained. The success of this purely mechanical method of synchronisation depends wholly on the supposition that there is no lag in the action of the disc valve or in the electrical system. The fact that the diagrams so obtained always give mechanical efficiencies agreeing with those obtained by different methods suggests that the supposition of no lag is justifiable and that this method of synchronising is sufficient. The initial timing, however, must be right, and if working for any length of time on one engine should be frequently checked. This exactness applies, of course, to any type of indicator, but becomes more important with higher speeds.

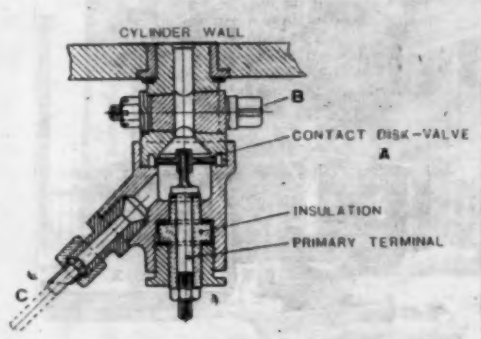


FIG. 5—BALANCE VALVE

Auxiliary Apparatus.—Besides the indicating and recording instruments, there is required (*a*) a supply of air at a pressure higher than that to be measured; also (*b*) a source of reduced pressure for recording pressures below atmospheric; (*c*) a distribution box for the various connections and also carrying regulating and release valves; (*d*) a high-tension coil with switch, condenser and batteries.

Description of Maximum Explosion and Compression Pressure Gauges.—The indicating mechanism is the same as that described above. Instead, however, of using the recording apparatus mentioned, two Bourdon gauges are employed. One gauge, reading to 750 lb. per square inch, is used for explosion pressures, and the other, reading to 200 lb. per square inch, is used for compression pressures. Each gauge is modified in such a manner that its pointer forms the earth of a high-tension electrical circuit, its extremity being separated by a short air gap from a brass bevelled ring, which is insulated from the remainder of the gauge and is connected to the high-tension terminal of an induction coil. Consequently the air gap between the extremity of the pointer and the bevelled ring acts as a spark gap when the primary circuit of the coil—which includes the indicating mechanism—is broken. This air gap lies directly over the pressure numbers of the gauge face. The high-tension current is conducted to the gauges through a change-over switch and a change-over cock supplies the high-pressure air to whichever gauge is being used. With a suitable gauge the same principle may be applied to the measurement of the *minimum* pressure of a cyclic pressure change.

Applications.—Both instruments will cover the range of measurements referred to below, although the indicator gives all the information which the maximum pressure gauges can give:—

(*a*) Measurements of average maximum and extreme maximum pressures occurring in any cycle, also pressures caused by pre-ignition or detonation.

(*b*) Accurate measurements of indicated horse-power and cylinder pumping losses.

(*c*) Production of air cards as well as explosion pressure cards.

(*d*) Diagrams of suction and exhaust strokes.

(*e*) Diagrams of cyclic change of pressure in the inlet and exhaust pipes.

Generally the apparatus is capable of measuring any cyclic change of pressure from 4 lb. to 1000 lb. per square inch absolute, at any speed likely to be met with in practice, and with considerable sensitivity.

The indicator shown on p. 102 is the experimental instrument which has been in use for eighteen months and with which nearly 3000 diagrams have been taken at speeds varying from 600 to 2500 revolutions per minute. As an indication of its robustness, it may be mentioned that it was fitted for six months to an engine undergoing development tests, and upwards of 1500 diagrams were taken, chiefly at speeds from 1000 to 1200 revolutions per minute; during the whole time no adjustments were made to the recording mechanism, and only an occasional periodic light grinding given to the contact disc valve.

As a result of the experience gained with this instrument, six new indicators have been made which, although retaining the essential features of the original indicator, are much more compact and have all the auxiliary apparatus, batteries, and coil enclosed in the casting carrying the recording drum, indicating cylinder and link work.

In connection with this indicator it is desired to acknowledge the work of the late Squadron Leader G. H. Norman, R.A.F. (Associate Member). Three years ago experiments were initiated by him at the Royal Aircraft Establishment to evolve an indicator which would record diagrams remote from the engine with entire satisfaction at high speeds, either on the bench or in the air. The subsequent investigation and development of these proposals was carried out by the author of this paper.

Diagrammatic Sketch of R.A.E. Indicator on Engine.

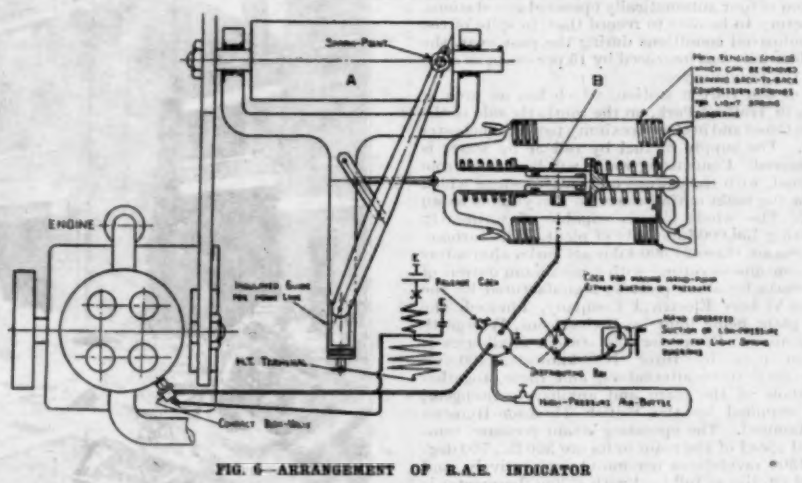
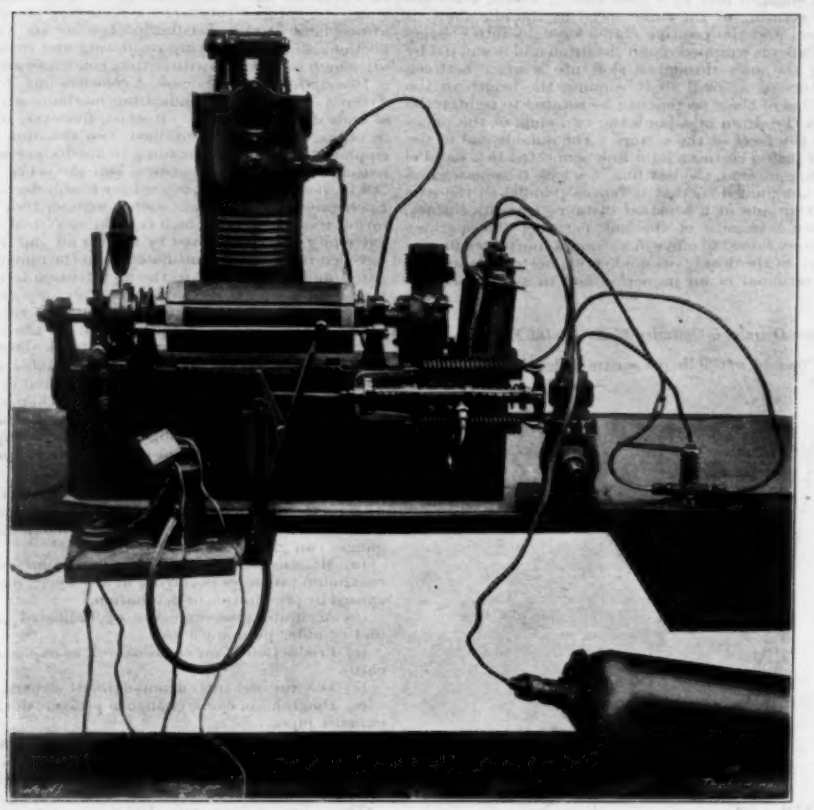


FIG. 6—ARRANGEMENT OF R.A.E. INDICATOR

THE SILVANUS THOMPSON MEMORIAL LECTURE.—We understand that among the demonstrations which will be given by old students at Finsbury Technical College after Sir Oliver Lodge's lecture on February 1st, in memory of the late Professor Silvanus P. Thompson, are to be the following:—Mr. Mordey, the oldest-known student, will show some effects of alternating magnetism; Professor Coker will demonstrate the strains set up by cutting tools, as shown under polarised light; Professor Desch will project micro-photographs of various alloys; Professor Eccles will show novel applications of the thermionic valve; and visitors will be entertained by a wireless concert, the reception being arranged for by Mr. Franklin. The plant of the College will be operated by present students.

THE R.A.E. ELECTRICAL INDICATOR

(*For description see page 100*)



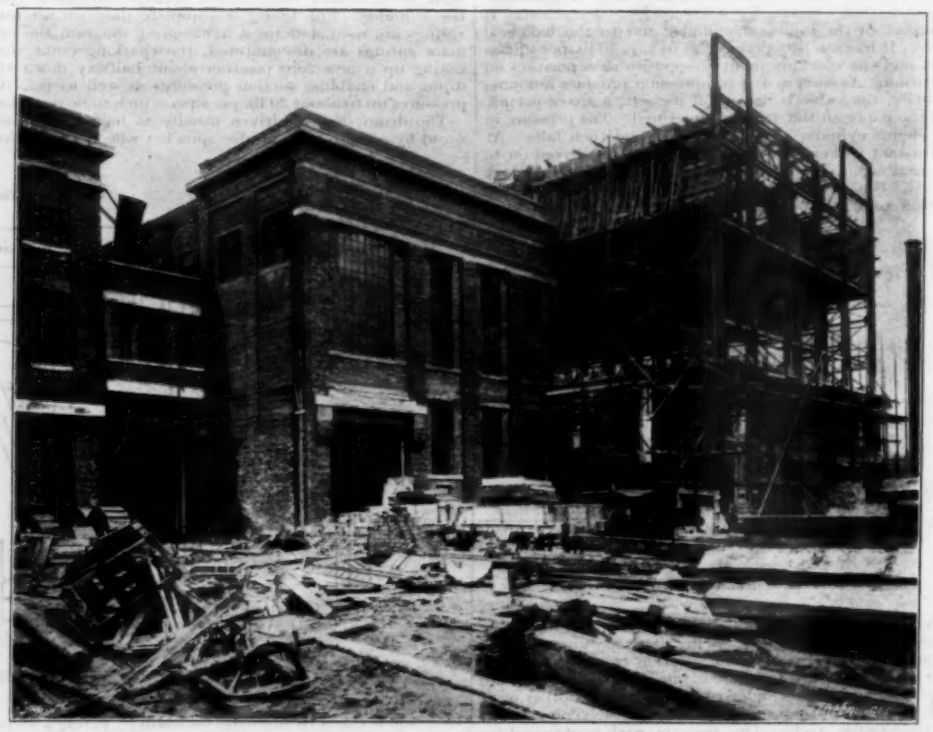
Barton Electric Power Station, Manchester.

DURING the past year very considerable progress has been made towards the completion of the Barton Power Station. The 33,000-volt mains connecting the Barton station with Stuart-street and also with the three new district centres, viz., Oldham-road, High-street, and Moss Side, have all been laid, and it is anticipated that preliminary runs of the generating plant will be possible by May next. At High-street and Stuart-street transformers of the outdoor type are being installed, as well as high-tension outdoor switchgear at the former station. During the coming year Mr. Pearce proposes to shut down the steam plant at Dickinson-street station and replace it by sub-station plant with a capacity of 20,000 kilowatts. The Stuart-street station is now complete as regards generating plant with a total capacity of 107,000 kilowatts, and it is among the largest single power stations in the country. Another feature of the coming year's programme is the erection of four automatically operated sub-stations. It is satisfactory to be able to record that, in spite of the depressed industrial conditions during the past year, the output of electricity has increased by 15 per cent., as compared with the previous year.

The site of the Barton station, which has an area of 14¼ acres, is in Trafford Park, on the southerly side of the Bridgewater Canal and in close proximity to the Manchester Ship Canal. The supply of fuel by rail or by water is therefore assured. Condensing water will be drawn from the Ship Canal, with the sewage and subsoil water which passes down the main outfall sewer to Davyhulme as an alternative. The whole site is capable of ultimately accommodating 150,000 kilowatts of plant. The turbine-house will contain three 27,500-kilowatt turbo-alternators (maximum continuous rating) with a maximum output of 31,250 kilowatts for short periods, manufactured by the Metropolitan-Vickers Electrical Company, Limited, the condensing plant being built by Richardsons, Westgarth and Co., Limited. Power for the station auxiliaries is furnished—in part—by three 1000-kilowatt, 400-volt "house service" turbo-alternators, and these, together with the whole of the main and auxiliary switchgear, have been supplied by the British Thomson-Houston Company, Limited. The operating steam pressure, temperature and speed of the main units are 350 lb., 700 deg. Fah., and 1500 revolutions per minute respectively, and a vacuum of 29.1in. at full load with a 30in. barometer is to be maintained.

The boiler-house is 314ft. long by 87ft. wide with a total height of 86ft. The heights of the floors are as follows:—Firing door to fan floor, 43ft.; fan floor to underside of roof principal, 18ft. 6in. The coal bunkers, to contain thirty-six hours' supply, which are of reinforced concrete, are carried at the level of the fan floor, the level of the roof being about 94ft. above ground floor level. Steam is supplied from nine Babcock and Wilcox water-tube boilers of the double-fired marine type. The most efficient rating is 100,000 lb. per hour actual evaporation, but each boiler is capable of maintaining an actual evaporation of 120,000 lb. per hour when supplied with fuel having a calorific value of not less than 10,500 B.Th.U. Each boiler, with its complementary chain-grate stokers, superheater, economiser, air heater, chimney and induced and forced draught fans, is a complete unit in itself. The ash basement of the boiler-house is at ground level, permitting standard-gauge railway wagons or road transport wagons to be fed directly from the ash discharge hoppers of the respective boilers. Thus suction ash plants or ash conveyors are dispensed with.

For the purpose of dealing with canal-borne coal a dock and lay-by have been constructed, the dock being 320ft. long by 50ft. wide, and the lay-by being 250ft. long by 50ft. wide. The dock walls are constructed of mass concrete. Coal will be unloaded by means of two overhead travelling cranes. To connect these dock works with the Bridgewater Canal it has been necessary to raise the towpath to provide headroom for the necessary bridge, and the Corporation has been compelled by Act of Parliament to provide, in addition, a footpath connecting the new road with Barton Bridge. The coal-unloading viaduct receives the coal from the double line of way, which passes over the new bridge over the Bridgewater Canal, and is provided with three hoppers into which the coal is discharged from the wagons by electrically operated end tippers. The fuel thus brought by rail is delivered from the hoppers to a system of bucket conveyors and thereby transferred to the boiler-house bunkers or into storage on the land. Alternatively, the same conveyors are used for withdrawing coal from the silo storage. Hoppers are provided in the end wall of the silos for feeding the conveyors with canal-borne coal. The foundations and walls to the silos and viaduct are constructed of mass concrete, the roof to the silos, the viaduct and receiving hoppers being of reinforced concrete. The coal-unloading plant has been supplied for the most part by W. J. Jenkins and Co., Limited, of Retford. A storage capacity of some 25,000 tons is provided, equivalent to approximately seven weeks' consumption, with all three main generating units in operation. Coal received by rail is weighed in the trucks before unloading; coal received by canal is weighed by two automatic machines fed by grabs or boxes; coal taken from storage to the boiler bunkers is also weighed by automatic machines.



THE BARTON POWER STATION

PERSONAL AND BUSINESS ANNOUNCEMENTS.

UNITED BRASSFOUNDERS AND ENGINEERS, Limited, ask us to state that they have transferred their head office and works from Manchester to their works at Ormskirk, Lancashire.

MR. DAVID BROWNLIE informs us that he has left Manchester, and that his permanent (and only) address will be in future—46, Grange-road, Ealing, London, W. 5. Telephone, Ealing 2344.

MARSHALL, SONS AND CO., Limited, of Gainsborough, inform us that their senior representative, Mr. Walter L. Keightley, who lately resided at Nottingham, has now removed to 78, London-road, Reading, Berks.

A. EGERTON KIDNER, Assoc. M. Inst. C.E., M.I. Mech. E., asks us to state that on February 1st he will remove his office from 32, Queen Victoria-street, London, E.C. 4, to Windsor House, Victoria-street, Westminster, S.W. 1. Telephone No. Victoria 4302.

WE are asked to state that Mr. J. W. Kirkland, who for many years has been managing director of the South African General Electric Company, of Johannesburg, has been appointed manager of the London office of the International General Electric Company, of New York. Mr. Kirkland will arrive from South Africa to take up his new duties about March 1st.

ENTERTAINMENT TO CHILDREN OF WORKPEOPLE.—On Wednesday afternoon, the 10th inst., the children of the workpeople of Fry's Metal Foundry were entertained to a New Year's Party by the office staff. Over forty children of all ages from six months to fourteen years, as well as their parents, were present. The programme included tea, games, a Punch and Judy Show, a ventriloquist, and a distribution of toys from a Christmas tree by Father Christmas. Mr. and Mrs. John Fry, together with other guests, were present during the afternoon, and the entertainment was a great success.

CONTRACTS.—Gwynnes Engineering Company, Limited, has secured the latest two large pumping engine contracts placed by the London County Council. The first is for the pumping machinery for the new storm water pumping station at Hammersmith, which will consist of five 42in. gas-driven centrifugal pumping engines, for dealing with a total of 1000 tons of storm water per minute; and the second that for the Abbey Mills sewage pumping station at Stratford, E., which will consist of three triple-expansion double-acting enclosed forced-lubrication engines, each coupled direct to a 30in. Gwynne "Invincible" centrifugal pump, and of two double-acting engines coupled direct to 16in. Gwynne "Invincible" centrifugal pumps. The above units will be complete with surface condensers, air and circulating pumps, valves and all the usual accessories.—In its issue of December 15th, the *Review of the River Plate* (Buenos Aires) said that one of the largest orders placed in South America for railway signalling apparatus had recently been awarded to Ramsay, Bellamy and Co., Limited, of Buenos Aires, by the Argentine State Railways. The contract represents three-quarters of a million pesos, Argentine currency, and will be carried out by Tyer and Co., Limited, signal engineers, Dalston, E. 8.—William Shepherd and Sons, Limited, of Milkstone, Rochdale, have recently supplied to the Liverpool Corporation consignments of asphaltic slag for roads.—Robert Hudson, Limited, of Leeds, have recently booked orders representing over 100,000 tons of British steel railway material, including rails, sleepers, points and crossings and rolling tock for Africa.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Effect of the Ruhr Invasion.

THE iron and steel market situation has this week been complicated by the new enterprise of the French and Belgian armies in the Ruhr, the consequences of which no one can foretell. Accordingly the market is going warily. The new deveopments on the Continent involve considerable displacements of trade. One of the first effects has been to make buyers more dubious than they were before as to the reliance to be placed on supplies of iron and steel, not only from Germany but from France, Belgium, and Luxemburg. This week it is reported that foreign steel works are not fulfilling their commitments with English buyers, consequently users of this material are looking to the home producer to satisfy their requirements. The disorganisation of the continental trade is accordingly diverting business to British manufacturers. Not only is this so, but makers of raw iron on the North-East Coast have this week received considerable orders from the Continent. Tonnages are so large that stocks are said to be exhausted, and a veritable famine is likely to exist in this district until more blast-furnaces can be got into operation. With a shortage on the North-East Coast there is prospect of a better call for Midland iron than at present exists. The new situation in Europe will conceivably assist the manufactured iron trade of this area, for it should secure the industry against inroads in the home market. Nevertheless, it is considered that the effect of the latest move by the French on the developing trade movement can in the long run hardly be other than detrimental for the unsettled conditions will retard progress on big undertakings, which are the essential foundation of a steady trade recovery.

Price Advances Maintained.

The enhanced prices of iron and steel have been upheld on the Birmingham market this week, but there seems no disposition to force the pace unduly, and thereby endanger the whole forward movement. The position is one of some difficulty, and both buyers and sellers are exercising caution. There is an increased demand sufficiently strong to stand a somewhat higher level of prices. If the demand goes on expanding it may be impossible to accelerate the output of raw material at an equal pace, and the control would automatically pass to the producer. On the other hand, there is the probability of a considerable advance in prices checking demand. This is a contingency which has a steadying influence on the market. Fuel supplies are still a source of worry to iron and steel masters. Prices continue to harden, and further pressure from the Continent for supplies will give an added stimulus to rising values. Inevitably dearer fuel means dearer iron and steel. Thus far the levelling up of iron and steel prices has been kept well within bounds. If the basis of production costs is to be upset, and we have to begin all over again, demand may be stimulated temporarily, but progress generally will be arrested. Iron and steel masters are hoping that they will now get a larger proportion of the home consumers' business. It is not a comforting reflection that after all the sacrifices they have made to get the British iron industry on its legs again, the diminishing tendency of iron and steel imports should have been sharply reversed in December of last year. In the previous month the total imports of iron and steel had fallen to 79,807 tons, against 90,638 tons in October. The last month of the year, however, saw the total rise to 114,011 tons.

Pig Iron Continues to Improve.

Pig iron is selling better and consumers are ready to buy forward. But makers insist upon better prices in view of the very uncertain state of the fuel market. The great obstacle ahead is undoubtedly the fuel supply. If more blast-furnaces are to be blown in there must be a bigger output of coke. Smelters fear that the opportunities offered by the export market may mean further drafts upon the available supplies, and that instead of the steady broadening of the base of trade upon which a real recovery depends there may be a period of unwholesome competition in which the new momentum will loose itself. Added to this is the demand for pig iron from the Continent, which has made itself felt in the markets on the coast this week. Large tonnages have been called for, and, with a shortage of iron imminent, prices are said to be leaping up. Further benefit is expected to arise from a revival of American buying, following a decided recovery of prices in the United States. A number of American offers have, however, been refused this week on the ground that they do not offer sufficient prospect of profit, while many furnaces have no considerable quantity of iron to spare for foreign customers. As far as the Midland market is concerned, although some fancy prices have been heard of, the tendency is for the market to move on a fairly even keel Northamptonshire furnace owners who were in attendance on 'Change in Birmingham to-day—Thursday—and who quoted 72s. 6d. for forge a week ago wanted 74s. or 75s. to-day, and Derbyshire forge could not be bought under 77s. 6d. Stringency has developed in this department because, owing to the unprofitable state of the trade for a long time past, the make of forge iron has dwindled to very small proportions. Foundry iron was dearer. A week earlier Northamptonshire No. 3 could be bought at 82s. 6d. This was refused to-day, sellers asking 85s., though business could be done at rather less. Derbyshire houses generally quoted 85s.

Manufactured Iron Prices.

Prices of manufactured iron of Midland make remain firm. The Staffordshire ironworks are deriving much benefit from the increasing activity of the Birmingham rolling stock works, of which I have more to say in another paragraph, a good deal of iron being called for for the fitting up of wagons. The maintenance of the marked bar standard at £13 10s. has a steadying effect on the other branches, which were inclined to move rapidly a week ago. The Staffordshire works are finding it no easy matter to secure remunerative prices, but they rely upon their increasing activity to help to give a profitable tonnage of output. They have not found it possible to follow the lead of Lancashire makers with regard to the advance in prices of Crown bars. Though good Staffordshire merchant, or Crown bars, are obtainable at £10 15s. to £11, Lancashire makers have been able to raise their figure by a further 10s. per ton. Nut and bolt bars have settled down at £10 per ton firm. Less is not taken, and makers declare that even that figure barely covers cost of production, and that consumers must expect higher prices when circumstances justify them. The nut and bolt trade is again fairly active. The quotation for Belgian bars is £8 2s. 6d. to £8 5s. delivered in the Black Country, but deliveries are uncertain, and the bulk of the business has been diverted to home makers in Staffordshire and Lancashire. Iron strip continues in good request at £10 15s. to £11.

Galvanised Iron Demand and Values.

Sheets, both plain and galvanised, are, again this week, appreciably dearer. Galvanised sheets of 24 gauge are quoted from £18 5s. to £18 10s. The latter quotation would appear to have now been adopted by all the largest works. Makers of black sheets are busier, and the recent rise in Welsh sheet bars makes prices generally firmer. A very brisk demand is opening for Scandinavia. It is with much satisfaction that the Galvanised Ironmakers' Association watches the increased demand from our overseas markets. It is now possible to give the completed demands for 1922 and to compare them with former years. The overseas orders last year for galvanised sheets represented business amounting to 513,225 tons, an aggregate which compares with only 211,600 tons the year before. Our chief customers in order of importance, it is very interesting to note, were India, which took 117,355 tons; Australia, 99,830 tons; the Argentine, 68,436 tons; South Africa, 43,800 tons; New Zealand, 23,400 tons; and Canada, 14,800 tons. All these markets showed an enormous improvement on the orders they furnished in 1921, India more than doubling her custom, while Australia approached three times the orders she sent us in 1921. It is instructive to give side by side with the total for last year the figures relating to some previous eventful years. In 1913, the year before the war, for, instance, the aggregate overseas trade in galvanised iron amounted to the magnificent figure of 762,000 tons, which is easily a record; in 1914, the figure fell to 566,600 tons; 1915, 286,400 tons; 1916, 117,210 tons, &c. It is clear from these figures that though, as I have said, the galvanised exports are encouragingly advancing, we have a long way to go before we reach pre-war totals. I may perhaps add in a parenthesis that in 1912 the exports were 658,650 tons.

Steel Values.

The steel market presents quite a healthy appearance. General inquiry continues on a good scale, and values are exceedingly firm. Indeed, the upward movement in prices continues. Staffordshire steel hoops have been advanced 10s. per ton to £11 10s. at works, on account of the increased cost of production. The structural steel branch has experienced an improved demand, and angles and tees are dearer by 5s. per ton. Some makers want 5s. above the official minimum for ship, bridge and tank plates, their quotation being £10. Most of the mills have satisfied their billet requirements for some little time. Prices, however, are slightly firmer on the week. Large mills accepting orders last week on the basis of £7 15s. now demand £8. Here and there it is possible to place an attractive order at £7 17s. 6d. Yet others do not take orders below £8 5s. The strength of the market is partly due to the continental position. On various pretexts the foreign steel works are not fulfilling their commitments with English buyers, and the isolated quotations coming forward are accordingly not proving attractive in spite of the decided price advantage they offer against the English quotations.

Rolling Stock Business.

There is a decided improvement in the heavy engineering trades in the Midland area. The more promising industrial conditions, to which I have referred in my last two letters, have brought a considerable demand for additional rolling stock. There are more definite inquiries for new wagons to be used on the railways of this country than for a number of years past. They come principally from private trading interests, however, the railway companies not having as yet made any move of special import. They are expected to enter upon a more progressive policy, however, as the new administrations get into working order. Orders placed a little while ago on account of a few of the collieries have been followed by others from the coal mining districts. Some of the big merchants are also taking steps to strengthen their resources. The overseas demand for wagons develops slowly, but some substantial orders have lately been received in this district on Indian railway account. Though the outlook has materially improved, the wagon shops of Birmingham and the Black Country will require many more orders than they have yet received to afford full employment for any length of time.

Engineering.

Those engaged in the pumping machinery branch of the engineering industry in Staffordshire are finding business much brighter than for some time past. They report that inquiries are of a healthy character, and that some foreign business is opening up. Heavy edge tool firms in this district have more orders on their books. One very large firm is employing more men than it has been doing for two years. The Indian market is better, Siam is looking up, and there are signs of an improvement in Brazil. Inquiries are of a more engaging character, and orders show a tendency to increase in volume. The improvement in the Coventry motor engineering industries is maintained. Week by week the unemployment figures are declining, a fact which in itself is an indication that the various firms are gradually building up to their full complement of workpeople. The principal light car manufacturers are making steady progress, but the more expensive luxury cars are still only in moderate demand. In the commercial motor section inquiries are improving materially, but buyers still wait until the last minute before placing their orders. Overseas business is slowly improving, more particularly for Australia and New Zealand. The improvement is also reflected in the busier atmosphere pervading the foundries and body-building establishments. The feeling that conditions have reached a more or less stable basis is giving confidence. In other directions work on aircraft is finding employment, and the big electrical concerns are sharing in the general improvement.

Continued Decline in Unemployment.

There is a considerable fall in the number of unemployed registered at the Labour Exchanges in the West Midland area. When the year opened those out of work numbered 176,354, and on January 8th the number stood at 176,548. The latest return, made up to January 15th, shows that 169,724 were registered as unemployed. This is a decrease of 6630 in a fortnight, and augurs well for the year 1923. The number of workless in the various important towns in this area are:—Birmingham area, 56,452; Coventry, 5864; Cradley Heath, 7567; Dudley, 5450; Smethwick, 6964; Walsall, 7472; West Bromwich, 4314; Wolverhampton, 10,494; Longton, 5179.

Miners' Wages.

There is now relatively little unemployment in the coal trade in this area, and reports from the districts show that wages, at last, are definitely on the upgrade. It is considered that the trade has now passed the worst, and with the demand improving, both at home and on export account, the industry may presently be working once again at full capacity. For the fourth month in succession miners in the eastern area, which embraces the important coalfields of Yorkshire, Nottinghamshire, Derbyshire, Leicestershire, Warwickshire, Cannock Chase and Pelsall, have received a wages advance of 2.92 per cent. Wages in this area have now increased by 15.61 per cent. above the minimum.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

General Outlook.

THE markets here for iron and steel are firm and rather more active, but there is not very much being done in the non-ferrous metals. One cannot say that the general position in these metals is worse than it was, but only that the revival which has occurred in the demand for iron and steel has not yet reached them. Of course, in general engineering the first results of increasing work are naturally seen in iron and steel, and later on should come the demand for the other metals. Hence there is hope for the non-ferrous metal market if the improvement in iron and steel can be maintained. There is still some scepticism on this point in the Manchester district, and when one talks with makers of iron castings one gets the impression that their views are not nearly so optimistic as their purchases of pig iron would seem to suggest. Perhaps many of them have bought pig iron because the price in Manchester is relatively low. If the Manchester price were upon a level with the Cleveland prices the cost of No. 3 foundry iron delivered in Manchester would be well over £5 per ton.

Metals.

The copper market has been steady and quiet for some time, with a slight tendency to go back, but this is probably only a temporary phase. It does not seem probable, or even possible, that any serious fall can occur in copper prices, at any rate so far as standard and refined ingot copper are concerned. The prices for manufactured copper and brass are in a different category, and are in no regular relation to the price of the metal or to the present costs of manufacture. This is clear when one compares yellow metal rods at 6¼d. per pound with copper rods at £96 per ton, or brazed brass tubes (for home consumption) at 1s. 1¼d. per pound with solid drawn copper tubes at 1s. 1¼d. per pound, or brass sheets at 10d. with yellow metal sheets at 7¾d. Reports from America suggest that the copper market on that side has again become rather weaker. The output of copper is still increasing and will require a further expansion in consumption; but it is fairly certain that the European demand will not be so good as it was last year. The possible collapse of German industrialism is a very serious matter for the copper market, and especially for the American producers, who disposed of a large quantity to Germany last year. In this country no doubt there will be an increasing disposition on the part of copper consumers to hold larger stocks, for the reason that no further serious fall in prices is expected, and the policy of stocking is more likely to be advantageous than the late policy of buying from hand to mouth. The change from the one policy to the other will make a considerable difference and help to support the market. Tin has been a fairly steady market round about £180 per ton. There are some who still believe that the price will touch £200, but speculation in tin does not seem to be so active as it was. There is rather a better demand from the tinplate trade, but the demand from the engineering industry is still very poor. The market for lead remains steady at the high prices which have been established so long, and one does not yet see any probability of reaction. The surprising thing is that these extremely high prices do not stimulate output to any considerable extent, and one cannot believe that the expenses of production have increased to anything like the same extent. Spelter has been a quiet steady market, but the big backwardation on forward metal is being reduced. It stands now at a fraction over £2 per ton.

Pig Iron.

The market here for foundry iron is very firm, and it seems certain now that the Derbyshire makers will have no difficulty in establishing the price of 85s. at the furnaces for their No. 3 pig. Founders here are inclined to hesitate about the advance, but this is mainly because a good many of them have considerable quantities to come in under the old contracts at a cost of 90s. delivered in Manchester, or roughly at 81s. 6d. or 82s. at the furnaces. Now that the Cleveland makers have again advanced their price for No. 3 to 95s. at the furnaces, the demand of the Derbyshire ironmasters for 85s. seems to be modest enough. The rise in Cleveland iron is, of course, caused by the idea that the Continent will be compelled to buy British iron for shipment now that the activities in the Ruhr Valley seem likely to be stopped. This may not affect Midland iron directly, but indirectly it should have a strengthening effect on all prices. The price of Scotch iron in Manchester has again been raised, and most sellers now want 117s. 6d. per ton delivered. This advance tends to check still further the consumption of Scotch iron in this district.

Steel.

The market for finished steel is about as it was, perhaps a little firmer, but there has been no definite advance in the Midland prices. It is noticeable, however, that the Scottish and North of England makers are putting up their prices to a level with those current in the Midlands, and one does not hear so much about their cheaper quotations for plates and sections.

Scrap.

Both steel and wrought iron scrap are now very firm, and so far as can be seen the supply is not equal to the demand. On the other hand, there is still an excessive supply of foundry scrap, although the advance in pig iron makes dealers in this material a little firmer than they were. It is, however, not yet easy to sell broken machinery scrap at 85s. per ton in Manchester, although it ought to be worth fully 95s.

Mid-Lancashire Electricity Supply.

During February the Electricity Commissioners will hold an inquiry at Preston with regard to the future supply of electricity in the Mid-Lancashire district. There will be submitted two rival schemes. Preston and Blackburn will propose a joint electricity authority, while the boroughs of Burnley, Blackpool, Accrington, Bacup, Colne, Darwen, Haslingden, Nelson and Rawtenstall will suggest an alternative scheme for a Joint Electricity Board with advisory functions only. Preston and Blackburn will propose that before 1931 all existing stations, excepting those at Blackburn and Rawtenstall, should be closed, and that the whole district should be supplied with current from the three stations at Preston, Blackburn and Burnley. This will involve the erection of new generating stations at Preston and Burnley, the existing stations at Accrington, Blackpool, Fleetwood, Nelson, Rawtenstall and St. Anne's being retained as peak load or emergency stations for a time until the three main stations can supply the whole district. The alternative scheme submitted by the boroughs mentioned above is for a Joint Advisory Board, retaining their own generating plants. The estimated capital expenditure on the Preston and Blackburn scheme between 1922 and 1926 is £741,875 and between 1926 and 1931 £820,000. New transmission lines, transformers and switchgear will cost £470,225, making the total cost of the second part of the scheme £1,290,225. The total outlay up to 1931 will therefore be £2,032,100, which is claimed to be less than would have to be spent on the alternative scheme. On the other hand, the total annual saving is estimated at £95,622.

Institution of Mechanical Engineers: North-Western Branch.

The annual meeting of the branch was held on the 18th inst. Mr. Charles Day occupied the chair. Mr. Dempster Smith, hon. secretary of the branch, presented the annual report and financial statement, which were approved. Mr. Dempster Smith was re-elected hon. secretary of the branch and Mr. F. W. Reed and Mr. Charles Day were re-elected to the committee. There being only one nomination for chairman—Mr. Alfred Saxon—he was elected unanimously to this position. A vote of thanks to Mr. Chas. Day for his services as chairman was proposed by Mr. A. Saxon, seconded by Mr. J. Bissett, and carried unanimously.

BARROW-IN-FURNESS, Thursday.

Hematites.

At the moment there appears to be a considerable amount of talk of an iron famine in some quarters, but this inclination is to be discouraged for obvious reasons. It was suggested that the trouble in the Ruhr district might affect the iron trade adversely, and this again was a foolish idea to foster, for the tendency would be the other way, if anywhere at all. Trade to-day is brisk, and there is an insistent inquiry for iron, and, what is more, there is a tendency for prices to rise. This all points to a better trade, and there is no reason to go and look for the cause. Some of the ironmakers in the North-West District are by no means unprepared for a bigger trade, and it will not take long to put more furnaces in blast. It is hardly likely that they will be caught napping. The continental trade is developing and cargoes are being dispatched every week to one port or another. The business done in the country is good and is growing, and there are more orders for future deliveries being placed, and, what is more, in larger quantities. It is a question how large orders for immediate delivery can be dealt with, and should the demand continue and increase, then there might be some possibility of a famine for a period, but not for long, unless the requirements exceeded the output of the district. It is rather a sign of the times that makers are seeing to the furnaces at present out of blast and are preparing them so that a start could be made without delay.

Iron Ore.

The iron ore trade is improving and the prospect is quite good. Some of the mines are working normally and others are likely to improve their trade in the near future. As the local iron trade improves, so will they. Not much foreign ore is coming in as yet, but there will be a change before long, for the stocks held are getting reduced.

Steel.

The steel trade is better and there is work at Barrow for several months on orders already booked for the rail mill. The hoop mills are well fixed for orders, and the special mill for steel rods, &c., is experiencing better trade. The Workington rail mill is also employed and has orders for some time. Foundries are experiencing better trade. There is a better outlook in the steel trade than there has been for many months.

SHEFFIELD.

(From our own Correspondent.)

The Upward Trend.

THERE are no outstanding new features of the steel trade to comment on this week, the general position showing little change. This means, however, that the revival movement is continued, although it may not be showing quite such a rapid advance as has been the case of recent weeks. There is still a great amount of unemployment in the city, the figures at the Exchange exceeding 36,000; but it is the case that in a number of the most important branches of industry work increases, while most of the departments, and among them those which have been most severely hit by the slump, have some progress to report. The heavy steel trade is still the best, and not only the basic but also the acid furnaces are turning out large tonnages. The armament departments are now feeling, to almost the full extent, the effect of the placing of the orders for the two new warships. The Brightside Foundry and Engineering Company, Limited, last week cast a 70-ton iron ingot mould for the making of armour plates. It was the first ingot mould of this size that had been cast by the firm since the war.

The Railway Departments.

The departments manufacturing railway tires, axles, springs, buffers, and other material of that class are still among the busiest and most hopeful. No large orders, like the £100,000 one from India which I mentiined in my last letter, have been announced this week, but there is a good flow of business from the home companies, from India, and from South America. Some of these orders are being diverted from Germany, as the troubles there are lessening confidence in that country's ability to give deliveries. The enormous capacity which Sheffield possesses for the production of railway material is not by any means fully employed yet, but it it considered likely that the demands upon it will go on increasing, and the absorption of the whole plant at an early date would cause no surprise. There is a continued demand for wagons, and a dismantled wagon repair works at Renishaw is to be re-equipped for both building and repairing, and brought into operation, it is hoped, by May or June. The biggest order for railway work reported during the week is one amounting to £53,000, which has been secured jointly by the Metropolitan-Vickers Electrical Company and C. A. Parsons and Co., of Newcastle. This is for a 15,000 turbo-alternator for the power station at Lot's-road, Chelsea, which is being got ready in anticipation of the opening of the new Underground lines. Messrs. Parsons are to construct the turbines, while the alternator itself will be supplied by the Metropolitan-Vickers Company. A contract for condensing plant for the power station has still to be placed. At the same time, other alterations are to be made at Chelsea, to perfect the existing electrical plant, at a cost of £47,600. A contract has been let during the week for the construction of a new branch railway line from Colsterworth to Stroxton, near Grantham. The new line, which will be 3 miles long, is to be built by Messrs. Logan and Hemingway, of Doncaster.

The Lighter Steel Trades.

There is not much advance to report in the state of the high-speed and crucible steel trades, although they continue to show some recovery from the bad position they have been in during the last two years. The file trade is badly employed, and there is only moderate activity in hand saws, hack saws, joiners' and engineers' tools. In some of these departments, in which Sheffield has long had to face the competition of Germany, it now has another serious rival in the United States. This is especially the case with files. The American file, offered at a very low price, has made much headway in the Colonies, and it is reported that an American firm of file makers is now sedulously cultivating the Italian market. There is much activity in pushing American hand saws in this country. The Sheffield circular saw still maintains its supremacy, whether for cutting iron or wood.

The Cutlery Trade.

The one really busy department at the cutlery works is that concerned with stainless steel table knives, and this is doing very well indeed. Last year's sales constituted a record, but there are indications that this year will show a further advance. Almost everybody wants stainless nowadays, and the demand for the old-fashioned sort shows a considerable decline. The selling prices of cutlery have undergone a substantial reduction during the last twelve months, and business is now carried on at a very moderate margin of profit. Trade in old-fashioned razors is very slow, and the competition due to stocks of German pocket knives and scissors is still very acute.

Progress of Stainless Steel.

Mention of stainless cutlery calls to mind the fact that the adaptation of stainless steel to a variety of other purposes is still extending. The latest suggestion is that it will be found useful in the glass-making industry. Dr. W. H. Hatfield, of the Brown-Firth Research Laboratory, delivered a lecture last week to the Society of Glass Technology, in which he brought this subject forward. He pointed out that stainless steel possessed a great advantage over cast iron in the fact that it did not grow under temperatures. Therefore, by its use, changing of shape and warping could be obviated. He considered that stainless might be tried as an alternative material for the construction of the parison mould. The fact that it could be hardened ought to be an additional advantage for use in the bottom of the blow mould. Some of the other purposes that occurred to him for which the material could be used in the glass industry were for pins, nozzles of blow-pipes, forgings for various purposes, and particularly for knives for glass cutters. Dr. W. E. S. Turner, the President of the Society, received these suggestions very cordially, and agreed that the time seemed opportune for trying stainless steel in the moulds, not only because of its non-scaling properties at high temperatures, but also because of the fine character of the grain obtaining in the material, which could not be obtained with ordinary cast iron. He mentioned that at the University of Sheffield during the last twelve months they had had one or two noses made of stainless steel put on blow-pipes, and although the trial had not gone sufficiently far to give adequate results, such results, as far as they had gone, were wholly satisfactory. As an instance of an actual new application of stainless steel, Dr. Hatfield mentioned that mirrors for scientific purposes had recently been made from it and used successfully.

Colliery Enterprises.

One of the largest new colliery schemes in the district is that of the Butterley Coal and Iron Company at Ollerton, one of the beauty spots of the Dukeries part of Nottinghamshire. Mr. Fitzherbert Wright, one of the directors, has issued an official statement, which shows that work has already been commenced on the undertaking, which will require financing to the extent of a million pounds. A fine seam of coal has been found, and a model village, with churches, chapels, and institutes will be built. The Miners' Welfare Committees in Nottinghamshire is pushing on with its schemes.

The Spurn Project.

The project for reclaiming 10,000 acres of land at Spurn Point, near Hull, is being kept well to the fore, though no actual progress has been made yet. The Minister for Agriculture, in a letter to Mr. Roger Lumley, states that before detailed inquiries and a survey can be made the Government will have to decide (1) whether any unemployment relief works should be undertaken which must necessarily go on continuously for some years; and (2) if any such relief works are undertaken, whether works of reclamation shall be included among them. If these two questions are decided in the affirmative, inquiries will at once be made with regard to the scheme.

NORTH OF ENGLAND.

(From our own Correspondents.)

A Serious Problem.

THE Cleveland ironstone mining industry is faced with a serious problem. The pressure of competition from outside has become very severe, and unless wages and conditions in the district can be so adjusted as to enable ore to be produced at a cost which will induce ironmasters to use it in preference to ores from Northampton and from overseas, the bulk of the Cleveland mines will stand idle. At present Northampton and foreign ores are delivered at the Tees-side ironworks at a price which, despite the heavy transit charges, is below the cost at which Cleveland ore can be obtained. Northampton is a particularly formidable rival. The beds of ore in that county are at the surface, and the methods are those of quarrying rather than mining, with the result that the costs of production are considerably cheaper as compared with Cleveland. It is a fact of much significance that while the Cargo Fleet Iron Company, which has interests in Northampton, is sending ore from there to its Tees-side works, two of its mines in Cleveland, Liverton and Stanghow are laid idle. The question of wages is an important factor in the problem of maintaining the ironstone industry in the area, and it was this question which occupied the attention of a joint conference of the mineowners and miners' representatives this week. Efforts are also being directed to the formulation of a scheme to simplify the adjustment of wages. Amongst the proposals advanced are improved base rates, the classification of workers, and the adoption of a new sliding scale to regulate wages. Under the proposed new arrangements there will be specific rates of pay for specific grades of work, and these rates will be uniform throughout the area. Thus will be avoided many of the complications which ensue in the fixing of wages when men doing the same class of work at different mines receive different rates of pay. The conference has been adjourned for a month. In the meantime the miners will decide upon the rates of pay they are to propose for the various classes of workers. They will also consider in the meantime the question of the hours of labour for underground and surface workers.

Cleveland Iron Trade.

Partly as a result of the Ruhr crisis diverting orders to Britain, but chiefly owing to the increased home demand, most of the makers of Cleveland iron have sold out, and a virtual famine now prevails. The situation has developed with astonishing rapidity, and many consumers have undoubtedly been awkwardly placed as a result. There have, however, been indications for weeks past that a scarcity was coming. With only ten furnaces producing Cleveland foundry iron, of which a considerable proportion passes molten into the adjacent steel works, the supply of iron for the open market is very limited. All the firms, with one exception, have closed their books

till March, and they are by no means keen upon committing themselves heavily for delivery so far ahead, seeing that costs of production are steadily rising. No. 3 G.M.B. Cleveland pig iron is quoted 97s. 6d. per ton f.o.t., but up to 105s. per ton is named on export account. Of course, such a price is absolutely prohibitive, and possibly it is meant to be. Certainly only those in urgent need would pay such a price, and if that figure continued to rule, English founders would have to close their works. It means that orders are having to be refused wholesale; it means the loss of our foreign markets and the renewal of the competition of Midlands' iron and possibly imported Belgian iron. Doubtless Cleveland ironmasters will be reviewing the position with a view to the possibility of starting more furnaces, but pig iron production at present leaves a very narrow margin of profit, and makers will need to be fully assured of the continuance of the demand before more furnaces are started. No. 1 quality is practically unobtainable, and if a small lot could be bought its value would be not less than 102s. 6d. per ton f.o.t. An average price for No. 4 foundry is about 95s., and for No. 4 forge 90s. per ton.

Hematite Pig Iron.

There is also a good demand for East Coast hematite pig iron. The price has been advanced to 97s. 6d. per ton for mixed numbers, but it is relatively cheaper than No. 3 foundry iron, and doubtless will be used where possible in its stead.

Iron-making Materials.

Foreign ore prices still trend upwards, but some big quantities have been disposed of. Imports this month are particularly heavy. The price of best Rubio ore is firmer at 23s. 6d. c.i.f. Tees. Coke prices, too, are advancing. Good medium furnace qualities are now at a minimum of 32s. 6d. per ton delivered at the works.

Manufactured Iron and Steel.

More encouraging accounts continue to be given of the manufactured iron and steel trade. Foreign competition is not so severe, and home orders are coming along in a fairly steady flow, particularly for shipbuilding material. Prices are all firmly maintained.

The Coal Trade.

The Northern coal trade is at present experiencing something of a boom, with the demand constantly expanding and prices gradually—if somewhat slowly—rising all round. The whole situation for this month and next is one of almost unexampled stringency. There is an exceedingly large demand from France, among which are inquiries from the State and other railways for Northumberland steams. This is most unusual for them, as they usually mix Durham coking with Welsh steams for railway purposes. There is also an increased call from Italy, which is over an extensive period. The German demand at the present time is exceedingly large and pressing. Buying is still going forward, but not quite with the same ease or assurance of a week or two ago. There is more than a little hesitation displayed in some quarters, which is due to the unstability and comparative worthlessness of German paper currency and the inevitable difficulty in arranging credits abroad to cover the value of their purchases. With this satisfactorily arranged there might continue a very heavy export trade for the best part of this year. There is also an augmented call from the Scandinavian countries, who are more anxious to cover their requirements than they were, and, according to report, have been holding off in the hope of being able to get on at cheaper prices than are ruling here. The quotations are not yet anything like stabilised. The tendency is still in an upward direction, with no indication as yet that the top figures have been reached. There are those, however, who view the present position as being purely fictitious, and are confidently looking for an early relapse in prices. But, as things are, every indication seems to point to a rise rather than a fall. The Northumberland steam coal section is very strong all round. Supplies are now only obtainable through merchants for this month. All classes of Durham coals are becoming scarcer every day, and quotations are gradually moving upward for all classes. The coke market is also setting firmer. Foundry makes, both beat beehive and patent oven, are advanced in price. Gas coke is very steady, but unaltered in price.

SCOTLAND.

(From our own Correspondent.)

Brisker Conditions.

THE industrial position in Scotland is improving. The change for the better is certainly slow to materialise, but there is undoubtedly a better feeling in industrial circles. The improved situation at the shipyards is being reflected in the allied trades, and manufacturers are hopeful of a broadening out in all directions. Overseas markets, too, are showing more interest, and in this connection the situation on the Continent has been responsible for the diversion of orders to local works. Some works have already arranged for the putting into operation of sections of their plants which have long been idle, and there is a general movement to make ready for increasing demands. The shipyards are practically all busy, and orders continue to come forward, and there seems to be justification for the anticipated demands for almost all descriptions of material.

Pig Iron More Active.

The pig iron market has been more active in appearance during the past few days. There is still plenty of room for improvement, however. Hematite has been moving off well in comparison to the output. Steelmakers are beginning to cover requirements, and some very good inquiries are in circulation. Foundry qualities have also improved their position a little in respect of home business. The export inquiry generally is of little interest at present. Hematite is firm at £5 7s. 6d., No. 1 foundry £5, and No. 3 foundry £4 15s. per ton, while an increase in quotations is not unlikely.

Steel and Iron.

The steel works have comparatively good orders on hand for plates and sectional material. Buying for forward delivery has been a little more in evidence of late, and a strong feeling is permeating the market. More business on home account is being done in steel sheets, and the export demand is increasing in volume. The prices being offered are not said to be very satisfactory, and makers are not inclined to put any large deals through. Galvanised sheets also show an improvement. Orders from abroad are coming forward in fair quantity, and firm prices have already been paid for good lots. As much as £18 to £18 5s. per ton f.o.b. has been quoted, while in some cases round about £19 per ton has been mentioned. Other branches of the trade, such as wagon and locomotive builders, bridge and structural engineers, have made a pertty fair start for the year. At the time of writing no official rise in steel prices has been mentioned. Orders may increase sufficiently to allow the present levels to be maintained, but there is a strong feeling that higher prices may be realised at any moment. The past week has witnessed a much better feeling in the bar iron trade. The local demand has increased, and export inquiries are larger than for some time past. The quotation of £10 10s. for Crown bars still stands. The steel department of this industry is also in a more satisfactory position. Re-rolled steel bars, also tube strips, are in increasing demand, and prospects are bright. Prices are likely to rise owing to the dearer quotations for imported billets. Meantime re-rolled steel bars are named round about £9 5s. per ton for home delivery, and about 5s. per ton less f.o.b. Scrap material of all kinds is difficult to secure, and, consequently, all prices are advancing. Encouraging reports are to hand concerning the steel industry at Mossend, Lanarkshire. It was reported at the week-end that trade had improved to such an extent that the mills at the Clydesdale Iron and Steel Works would start on the Sunday night. It is over two years since the men made a Sunday start.

Coal.

The Scotch coal market has developed a firm attitude during the past few days, especially as regards small stuffs, which have advanced in some cases as much as 2s. 6d. per ton. It was at first thought that the German situation would cause something in the nature of a "boom" in the coal trade here, but the latest information does not point that way. A better demand is certainly mentioned, but not to an extent indicating anything in the nature of a "rush." Inquiries are plentiful, but the financial difficulties are prominent. It is now said that any business passing on German account is merely the renewal of old contracts. There seems no doubt, however, that export demands are increasing, whether they emanate from Germany or not. The call for Lanarkshire fuel has been such that the working policy of so many hours per day and the number of days per week has been under discussion with a view on the owners' part of increasing the hours per day, if not the number of days per week. The union agents are, of course, opposed to any extension, and, in fact, are talking of a further decrease of working hours. Other districts besides Lanarkshire report better export inquiries, and mention of American and Canadian offers have been made. Swedish State Railways have ordered about 25,000 tons of Fifeshire steam coal to be delivered before the end of March. Aggregate shipments for the week amounted to 273,407 tons against 261,538 tons in the preceding week, and 195,885 tons in the same week last year. The home market continues quiet. Industrial orders are slow, and only house coal shows any animation.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Situation.

THE uncertainty prevailing in the steam coal export trade a week ago has since become more acute, and so far as this district is concerned the conditions have become quieter. Reports have been current of big German demands for coal being received in the North, but South Wales exporters have failed to find any appreciable extra demand from Germany, and at the time of writing there are no more orders on this market for German ports than is ordinarily the case. Reference was made a week ago to the expected improvement in the inquiry for coals for shipment to France, but here, again, it has not materialised; in fact, the conditions are not so satisfactory, and, despite the optimism of coalowners and the comparatively high prices demanded for supplies for February, shipment it is unfortunately the case that French importers are holding off. This may be temporary, but it is disadvantageous for trade, and the attitude of other continental buyers is much on the same lines. The French occupation of the Ruhr has not done business any good, and this is not altogether surprising, for the reason that there is the very important question of payment to be considered when purchasing coals, and, seeing that the disturbed political conditions abroad have been followed by adverse movement in the exchange, and there is no knowing what may be the position even a few days ahead, it is not inexplicable that continental buyers of coal should exercise caution. They want to know what the coals are going to cost them, and this is impossible with the rate of exchange liable to marked fluctuation. The Italian inquiry for coals from this district is also on a limited scale and American business has become less active. There seems to be some doubt whether the expected strike at the American mines on April 1st is going to mature. So far as is known there has been no buying on a substantial scale for the past fortnight; but it is probable that sales of individual cargoes will be arranged, as has been the case recently, these being purely to meet the shortage of supplies in the States and not in any way as a preparation against the prospect of a suspension of production in the American mines.

Patent Fuel Industry.

Representatives of the South Wales Patent Fuel Manufacturers' Association had an interview at the end of last week with the Roads Board of the Ministry of Transport, when the Ministry was urged to use its efforts to restrict the use by local authorities of coal tar pitch for road purposes. The opinion of patent fuel manufacturers is that the use of coal tar pitch on the present scale for road construction is having the effect of increasing the price and scarcity of this commodity to such an extent that patent fuel works are threatened with extinction. Sir Henry Maybury, on behalf of the Board, promised to report to the Ministry. In a memorandum on the question submitted to the Ministry of Transport it was pointed out by the Association that the potential output of the briquetting factories in South Wales is approximately 4,000,000 tons per annum, and immediately works now nearing completion commence manufacture the total will be increased by about a further million tons. The number of men employed directly in the industry is about 3500, and the capital involved is close upon £5,000,000. The proportions of small coal and coal tar pitch for a ton of patent fuel are approximately 90 per cent. and 10 per cent. respectively.

Swansea Developments.

It is reported that the cold storage scheme for Swansea Docks, which will lead to the establishment of regular imports of frozen meat, is now coming to a head, as the promoters have secured a lease from the Harbour Trust of a site on the town side of the King's Dock. The scheme, which is backed by men of influence, is said to be on a considerable scale. It is intended to deal with meat supplies from North and South America, South Africa and Australia. This week Swansea set up a new record in the matter of expeditious oil bunkering. The ss. Sjomond arrived at the King's Dock jetty on Monday morning's tide and departed three hours later on the same tide with 1300 tons of bunkers.

Current Business.

Comparatively little activity prevails on the steam coal market and the conditions are somewhat irregular, more especially for spot loading. The bulk of the collieries are well off in the matter of ready tonnage supplies, but this is not invariably the case, and, furthermore, the inability of some undertakings to get their steamers into berth has had the effect of causing some collieries to work irregularly for the want of empty wagons. The position is rather conflicting, as many colliery salesmen report that they are full up and have no coal to spare, not only for this month, but practically for the whole of February, and yet there are weak spots for immediate loading, and the inquiry for forward loading is not so good. The impression prevails that, apart from some unexpected developments arising from the political situation on the Continent, the coal market is on top, and that for coalowners to attempt to push up prices still higher will only have a detrimental effect in the long run. Best Admiralty large is quoted at 29s. to 30s., and second qualities at 28s. to 28s. 6d., but small coals are relatively the firmest spot in the market. Best steam smalls are scarcely obtainable for early loading, and salesmen are declining to accept less than 20s., and in some instances are indicating up to 21s. for February supplies. The anthracite section shows practically no change, except that machine-made nuts and cobbles are rather steadier. Patent fuel makers are not quoting for supplies ahead owing to the uncertainty prevailing regarding the supplies of pitch, which is still dear and scarce.

Latest News from the Provinces.

LANCASHIRE.

MANCHESTER.

Proposed New Engineering Works in Manchester.

THE Manchester Town Planning Committee has before it the proposal of the firm of Henry Simon, Limited, to build a new works on a site in Withington. The site measures 12½ acres, and the works are to be built on model lines, and although the committee views the project with favour, owing to the district being a residential one it is thought desirable to give the local householders an opportunity to express an opinion of the scheme. The firm's present works are at Stalybridge.

WALES AND ADJOINING COUNTIES.

Swansea Metal Exchange.

Firmness prevails in the tin-plate market, makers who have been getting 20s. 9d. per basis box, now quoting 21s. Higher figures are talked of. It is reported that the Asiatic Oil Company has placed a substantial order for supplies of tin-plates, which has been divided among the local works at the minimum price.

Coal Order.

It is reported that American buyers have purchased 100,000 tons of bituminous coals, but whether the order is for South Wales or north country coals is not definitely known.

WHITWORTH SOCIETY.—In reporting the meeting convened for the purpose of forming the new Whitworth Society, in our issue of January 19th, we inadvertently misspelt the names of some of the temporary Committee. The members of the Committee are as follows:—Dr. H. S. Hele-Shaw, Sir Henry Fowler, Dr. A. Morley, Professor E. G. Coker, Professor D. A. Low, Professor F. C. Lea, Mr. E. R. Dolby, Mr. H. R. J. Burstall, Mr. L. A. Legros, and Dr. W. A. Scoble.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	22/6
(1) Spanish	21/6
(1) N. African	21/6
N.E. COAST—	
Native	—
Foreign (c.i.f.)	24/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	5 7 6	—
No. 1 Foundry	5 0 0	—
No. 3 Foundry	4 15 0	—
N.E. COAST—		
Hematite Mixed Nos.	4 17 6	4 17 6
No. 1	4 18 6	4 18 6
Cleveland—		
No. 1	5 2 6	5 7 6
Silicious Iron	5 2 6	5 7 6
No. 3 G.M.B.	4 17 6	5 5 0
No. 4 Foundry	4 15 0	4 15 0
No. 4 Forge	4 10 0	4 10 0
Mottled	4 5 0	4 5 0
White	4 5 0	4 5 0
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	13 0 0	—
North Staffs. Forge	3 15 0 to 3 17 6	
,, ,, Foundry	4 5 0 to 4 7 6	
(3) Northampton—		
Foundry No. 3	4 4 0 to 4 5 0	
,, Forge	3 14 0 to 3 15 0	
(3) Derbyshire—		
No. 3 Foundry	4 4 0 to 4 5 0	
Forge	4 2 6	—
(3) Lincolnshire—		
Basic	4 7 6	—
Foundry	4 5 0	—
Forge	4 2 6	—
(4) N.W. COAST—		
N. Lancs. and Cum.		
Hematite Mixed Nos.	5 10 0	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 10 0	10 10 0
Best ,,	12 0 0	—
N.E. COAST—		
Crown Bars	11 0 0	—
Tees	10 0 0	—
LANCS.—		
Crown Bars	11 10 0	—
Second Quality Bars	10 5 0	—
Hoops	14 0 0	13 15 0
S. YORKS.—		
Crown Bars	11 10 0 to 12 0 0	
Best ,,	12 10 0	—
Hoops	14 0 0	—
MIDLANDS—		
Crown Bars	10 15 0 to 11 0 0	
Marked Bars (Staffs.)	13 10 0	—
Nut and Bolt Bars	10 0 0	—
Gas Tube Strip	10 15 0 to 11 0 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	12 0 0	—
Ship Plates ¼in. and up	8 15 0	—
Sections	8 7 6	—
Steel Sheets ⅛in. to ½in.	10 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	18 0 0

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	9 10 0	—
Angles	9 0 0	—
Boiler Plates	13 0 0	—
Joists	9 0 0	—
Heavy Rails	9 0 0	—
Fish-plates	13 0 0 to 14 0 0	
Channels	9 5 0	—
Hard Billets	8 15 0	—
Soft Billets	8 0 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 15 0	—
Light ,,	9 15 0 to 10 5 0	
Billets	8 15 0	—
MANCHESTER—		
Bars (Round)	9 0 0 to 9 10 0	
,, (others)	9 10 0 to 10 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	12 5 0	12 0 0
Plates	9 0 0 to 10 0	
,, (Lancs. Boiler)	13 10 0	—
SHEFFIELD—		
Siemens Acid Billets	11 0 0	—
Bessemer Billets	12 10 0	—
Hard Basic	8 15 0	—
Intermediate Basic	8 10 0	—
Soft Basic	7 15 0	—
Hoops	12 10 0 to 13 0 0	
Soft Wire Rods	10 0 0	—
MIDLANDS—		
Small Rolled Bars	9 10 0 to 9 15 0	
Billets and Sheet-bars	7 15 0 to 8 0 0	
Gas Tube Strip	10 5 0 to 10 10 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets (f.o.b. L'pool)	18 5 0 to 18 10 0	
Angles	9 5 0	—
Joists	9 0 0 to 9 5 0	
Tees	10 5 0	—
Bridge and Tank Plates	9 15 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	20/9 to 21/-
Block Tin (cash)	183 10 0
,, (three months)	185 15 0
Copper (cash)	64 15 0
,, (three months)	65 0 0
Spanish Lead (cash)	27 0 0
,, (three months)	26 15 0
Spelter (cash)	35 5 0
,, (three months)	33 5 0
MANCHESTER—	
Copper, Best Selected Ingots	69 10 0
,, Electrolytic	71 10 0
,, Strong Sheets	96 0 0
,, Loco Tubes	0 1 1½
Brass Loco Tubes	0 0 11½
,, Condenser	0 1 1¼
Lead, English	28 5 0
,, Foreign	27 0 0

FERRO ALLOYS.

(All prices now nominal.)

Tungsten Metal Powder		1/11 per lb.
Ferro Tungsten		1/5 per lb.
	Per Ton.	Per Unit
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23	10/6
,, 6 p.c. to 8 p.c. ,,	£21 0 0	8/-
,, 8 p.c. to 10 p.c. ,,	£20 0 0	8/-
,, Specially Refined		
,, Max. 2 p.c. carbon	£54 0 0	20/-
,, ,, 1 p.c. ,,	£64 0 0	22/6
,, ,, 0·75 p.c. carbon	£72 0 0	25/-
,, carbon free		1/7 per lb.
Metallic Chromium		4/9 per lb.
Ferro Manganese (per ton)		£15 for home.
,, Silicon, 45 p.c. to 50 p.c.		£11 2 6 scale 5/- per unit
,, ,, 75 p.c.		19 10 0 scale 6/- per unit
,, Vanadium		17/- per lb.
,, Molybdenum		9/6 per lb.
,, Titanium (carbon free)		1/2 per lb.
Nickel (per ton)		£130
Cobalt		11/- per lb.
Aluminium (per ton)		£82 to £100 (British Official.)

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	22 6
,, ,, Ell	23,6
,, ,, Splint	24/- to 26/-
,, ,, Trebles	23/3
,, ,, Doubles	21/6
,, ,, Singles	18/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	22/6
,, ,, Splint	24/-
,, ,, Trebles	23/3
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	22/- to 25,6
Screened Navigation	23/-
Trebles	24/-
Doubles	22/-
Singles	19/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	23/9
Secondary Steam	23/-
Trebles	23.9
Doubles	21/9
Singles	18/6

ENGLAND.

(8) N.W. COAST—	
Steams	29/-
Household	46/8 to 57/6
Coke	36/-
NORTHUMBERLAND—	
Best Steams	26/6 to 27/6
Second Steams	23.6 to 24/6
Steam Smalls	16/- to 17.6
Unscreened	20/6
Household	25/- to 28/-
DURHAM—	
Best Gas	25/- to 26/-
Second	23/- to 24/-
Household	25/- to 28/-
Foundry Coke	37/- to 40/-

	Inland.
SHEFFIELD—	
Best Hand-picked Branch	32/6 to 34/6 —
Barnsley Best Silkstone	28/- to 30/- —
Derbyshire Best Brights	24/- to 26/- —
,, ,, House	21/6 to 22/6 —
,, ,, Large Nuts	19/6 to 22/6 —
,, ,, Small ,,	15/- to 16/6 —
Yorkshire Hards	20/- to 21/- —
Derbyshire ,,	19/- to 20/6 —
Rough Slacks	9/- to 11/- —
Nutty ,,	7/9 to 9/9 —
Smalls	3 - to 5/- —
Blast Furnace Coke (Inland and Export)	22/- to 30/-

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	29/- to 30/-
Second ,, ,,	28/- to 29/-
Best Dry Large	27,6 to 28/-
Ordinary Dry Large	26/- to 27/-
Best Black Vein Large	28/- to 29/-
Western Valley ,,	28/- to 28/6
Best Eastern Valley Large	27/6 to 28/-
Ordinary ,, ,,	25/6 to 27/-
Best Steam Smalls	20/- to 20/6
Ordinary ,,	15/- to 18/-
Washed Nuts	25/- to 32/6
No. 3 Rhondda Large	29/- to 30/-
,, ,, Smalls	19/- to 21/-
No. 2 ,, Large	26/- to 27/-
,, ,, Through	21/6 to 23/-
,, ,, Smalls	16/- to 17/-
Coke (export)	40/- to 45,-
Patent Fuel	—
Pitwood (ex ship)	27/6 to 28/-
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	32/6 to 35/-
Seconds	30/- to 32/6
Red Vein	28/- to 29/-
Machine-made Cobbles	45/- to 47/6
Nuts	52/6 to 55/-
Beans	42/6 to 45/-
Peas	21/- to 23/-
Breaker Duff	11/- to 11/6
Rubbly Culm	14/- to 14/6
Steam Coals:	
Large	25/- to 26/-
Seconds	23/- to 25/-
Smalls	13,6 to 15/-
Cargo Through	18/- to 22,6

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—F.O.B. Glasgow.

(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

French Engineering Notes.

(From our Correspondent in Paris.)

The Ruhr.

THE Ruhr has been occupied as a means of exercising economic pressure upon Germany, and it is expected that the immediate result will be to provide the coal and coke necessary for the industries in Lorraine and elsewhere. So far the result is very poor compared with the cost of the machine that has been put in motion, and although the French affirm that they are prepared to carry on and wait patiently until they achieve their object, there are many who are beginning to doubt whether any profit can be derived from the occupation other than by a compromise which may benefit both countries. As a matter of fact, the situation is so inextricably involved that it appears almost impossible for France to carry out the policy which directed the occupation. In the same way that the Germans cast longing eyes upon the iron ore deposits of Briey, which they regarded as indispensable to the Lorraine industry and would certainly have annexed had they vanquished France, so the French see that there can be no hope for the Lorraine industry without the coke produced in the Ruhr. The two industrial districts cannot be separated economically. As soon as this fact was impressed upon the French they endeavoured to render themselves independent of the Ruhr by producing coke in the Saar suitable for blast-furnaces by a process of two-stage distillation devised by M. Charpy and others. The experimental results have been fairly satisfactory, but their practical realisation appears to be very difficult on account of the expense involved in transforming and reconstructing ovens, and it has therefore been necessary, as the Germans failed to deliver the specified quantity of coke, to enter the Ruhr and take what is required. There are those here that hold the view that as the seizure of the Ruhr means economic disaster for Germany, without bringing adequate advantages to the French, unless they are able to exploit the Ruhr Basin themselves, which is very problematical so long as they have to rely upon German labour, the only way out of the difficulty is for both countries to come to an understanding on the basis of an exchange of iron ore from France for coal and coke from the Ruhr. A few months ago negotiations were in progress between industrial groups in both countries for effecting this exchange, but the French Government refused to give its sanction so long as Germany failed to carry out the terms of the Treaty. Despite the vigorous action of the French the situation is rather worse than it was before, and unless unexpected developments arise it appears that there can be no hope except by some intervention which will have for its basis a co-operation of French and German industries in Lorraine, Briey and the Ruhr. Without an exchange of coke and iron ore there can be no prosperity for either of the districts.

Trade Relapse.

Meanwhile, the effect of the operations in the Ruhr, which are taking a more pronounced military character, is to cause a suspension of business in the iron, steel and engineering trades, for no one will give out orders so long as the situation remains uncertain. There is nevertheless plenty of work in hand, and much of it is delayed by the irregular deliveries of pig iron; but when contracts are worked off it is hardly likely that there will be much new buying until the outlook becomes more settled. It is understood that negotiations for the reconstitution of the *comptoir* of sheet makers are well advanced, and efforts will doubtless be made to revive the other unions of pig iron and rolled iron producers, whose disappearance has had a somewhat paralysing effect upon trade. The railway wagon builders are looking forward to receiving some large orders, including one for 4500 wagons from the Cie du Nord. For a long while past they have been engaged upon repairing old rolling stock.

Tram and Roadway Costs.

The Department of the Seine is devoting 400 million francs to improving and extending the electric tramway service in Paris and the suburbs, and in a report presented by the Commission some figures are given showing the cost of laying down the slot installations, from which it appears that the cost varies from 2,200,000f. per kilometre in the Boulevard des Batignolles to 4,700,000f. in the Boulevard Haussmann, the difference being due largely to the displacement of gas, water and compressed air mains and the more or less complicated character of the points. In the Place Saint-Augustin the cost of relaying the tram lines with slot contact was 1,800,000f. Other figures given in the Commission's report are to the effect that the total area of the public thoroughfares in Paris is 16,808,800 square metres. Of the roadways there are 5,416,200 square metres of granite setts; 2,461,500 square metres of wood pavement; 919,100 square metres of asphalt; and 672,000 square metres of macadam. The total length of the roadways is 1013 kiloms.

Rural Electrification.

If the programme for distributing electricity throughout the rural districts has been interfered with by the difficulty of procuring the necessary funds a good deal of progress has nevertheless been made with the laying down of generating stations in agricultural centres, and the Parliamentary Committee, which is interesting itself in the work of organisation, has this week discussed the ways and means of pushing forward the scheme. The undertaking is regarded as of particular importance for the country's welfare in the sense that by distributing current in the rural districts the conditions of existence will be much improved for the agricultural labouring community, which may be induced to remain on the land instead of migrating into industrial centres. As the State is unable to carry out its part of the agreement and provide subsidies for the laying down of installations it is proposed that the funds should be raised by local loans, which would be eventually repaid by the State. A Committee composed of deputies, engineers and local representatives has been appointed to draw up a scheme of rural electrification under conditions that will permit of its being carried out without immediate State participation.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

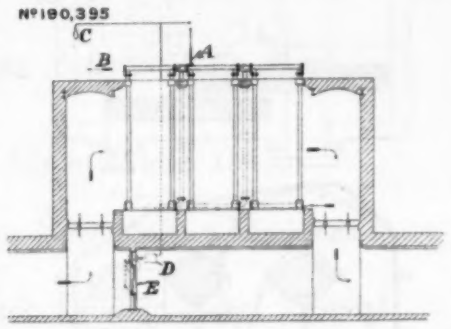
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

CONDENSERS AND FEED-WATER HEATERS.

190,395. March 11th, 1922.—ECONOMISER CONTROL GEAR, *Babcock and Wilcox, Limited*, 30, *Farringdon-street, London, E.C.*

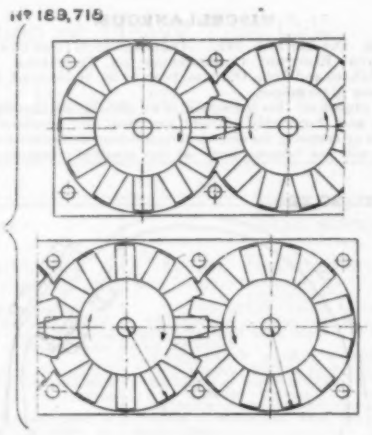
ACCORDING to this invention a mercury thermometer A is arranged in the economiser about one-third of its length from the outlet B. If the temperature of the feed water exceeds a pre-



determined limit the mercury completes an electrical circuit, which lights the signal lamp C and sets the motor D to work to open the by-pass damper E and thus let the flue gases pass straight to the chimney.—*December 21st*, 1922.

189,718. May 1st, 1922.—AIR-COOLED CONDENSERS, Aktiebolaget Ljungströms Angturbin, Arsenalsgatan 2, Stockholm.

The inventor states that it is sometimes difficult to find accommodation in the air-cooled condensers used in connection with steam locomotives for the fans used to draw the air through

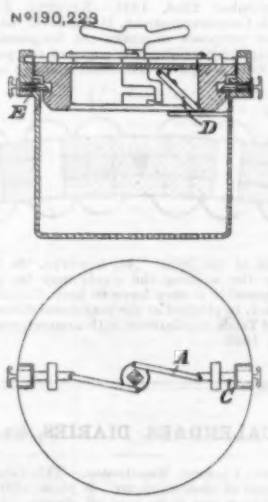


the condenser. He thus places the fans so close together that they overlap, as shown in the drawing, and the fan blades intermesh more or less after the fashion of the teeth of gear wheels. The fans must, of course, rotate in opposite directions.—*December 7th*, 1922.

SWITCHGEAR.

190,223. September 12th, 1921.—IMPROVEMENTS IN AND CONNECTED WITH MINING TYPE SWITCHGEAR, Frank Greaves Warburton, of 11, Upper Woburn-place, London, W.C.

The arrangement of the explosion-proof joint between the box and lid of the switch case described in this specification will be

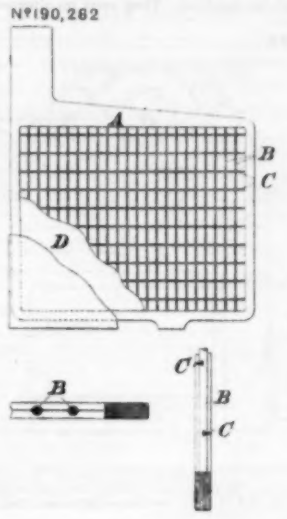


understood from the drawings, in which the distance between the faces forming the explosion-proof joint is exaggerated. For locking the cover rods A are connected with the switch handle, and if the lid is not in the correct position the handle cannot be rotated, as the bolts C strike the edges of the case. The spring actuated arm D also prevents the operation of the switch if the lid is not in its proper position. Additional locking devices are also provided at E.—*December 12th*, 1922.

BATTERIES AND ACCUMULATORS.

190,262. September 23rd, 1921.—IMPROVEMENTS IN STORAGE BATTERY PLATES, *The Chloride Electrical Storage Company, Limited, Clifton Junction, near Manchester.*

The frame A surrounds a grid composed of vertical rods B and horizontal tie bars C. The active material D is placed in the grid cavities and presents a horizontal unbroken surface

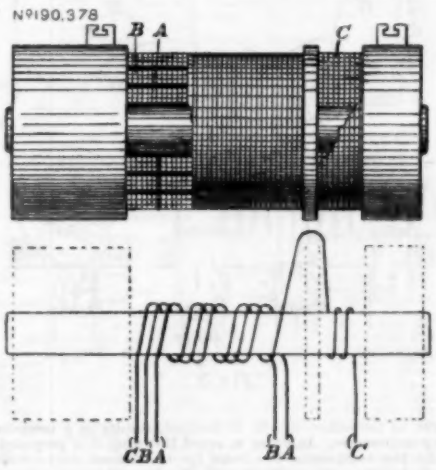


which extends entirely across the grid. The tie bars C may have different sections, but in all cases they are reduced to a knife edge at the front as illustrated.—*December 21st*, 1922.

TELEGRAPHS AND TELEPHONES.

190,378. January 9th, 1922.—IMPROVEMENTS IN OR RELATING TO ELECTRIC TRANSFORMERS, *The Western Electric Company, of Norfolk House, Victoria Embankment, Westminster.*

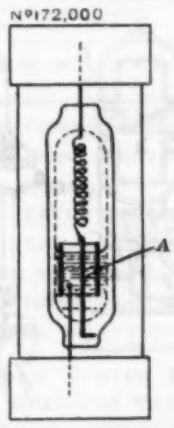
This invention relates more particularly to the type of transformer used in telephone sub-station circuits. One object of this invention, the specification states, is to provide an electrical transformer in which is combined effectively the usual transformer and the balancing network in an anti-side-tone tele-



phone circuit. Another object is to reduce the number of parts required in the subscriber's set. In general the invention consists in winding on the same magnetic core two closely coupled windings A and B answering the purpose of the transformer, and a third winding C somewhat loosely coupled to each of the transformer windings. This third winding performs a double function, acting as a transformer winding and as a balancing network.—*December 21st*, 1922.

172,000. November 16th, 1921.—IMPROVEMENTS IN METERS FOR TELEPHONE SYSTEMS, Siemens and Halske Aktiengesellschaft, of Wernerwerk, Siemensstadt bei Berlin, Germany.

The device described in this specification is for the purpose of



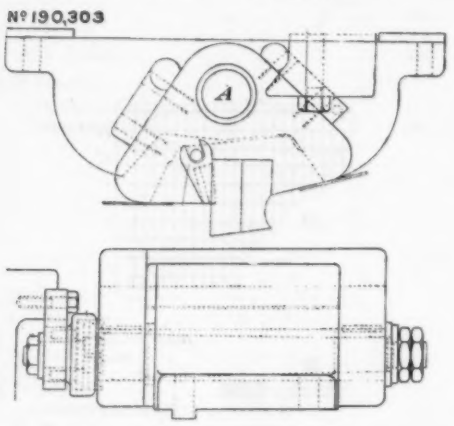
enabling telephone subscribers to be charged according to different scales or rates of charging. A copper conductor A is placed in an electrolyte and is eaten away by the subscriber's

telephone current, and the failure of the current indicates to the attendant at the exchange that the subscriber has made a predetermined number of calls. The number of times per annum that the conductor is replaced fixes the amount which the consumer is charged.—*December 21st*, 1922.

MACHINE TOOLS AND SHOP APPLIANCES.

190,303. October 17th, 1921.—GEAR CUTTERS, E. Parkinson and C. H. Smith, Canal Ironworks, Shipley.

This cutter box is intended for use on machines of the shaper type and is provided with two tools. One tool is for roughing and the other for finishing. They work on alternate strokes and



are brought into the working position by the tool-box rocking on the pivot A. Means are provided for positively rocking over the box at the end of each stroke.—*December 21st*, 1922.

PUMPING AND BLOWING MACHINERY.

190,429. December 16th, 1922.—TURBO-COMPRESSORS, Aktiengesellschaft Brown, Boveri & Cie., Baden, Switzerland.

This specification sets out a proposed system of operating turbo air compressors in such a manner that they can be used, in cases of emergency, for providing half the volume of air at double the normal pressure. The curves, Fig. 1, show at A the relation between pressure and volume for normal working, and at B the conditions when the two ends of the compressor are put in series to double the pressure. The transition from one

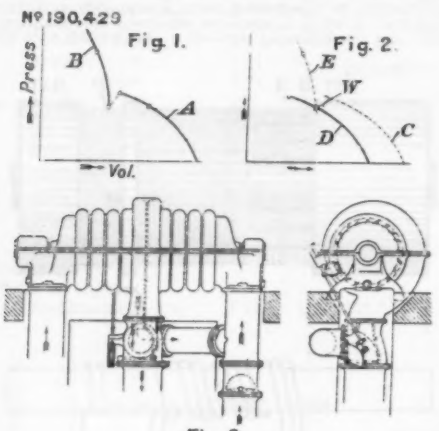


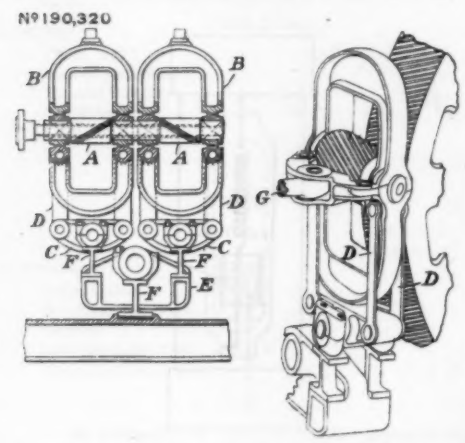
Fig. 3.

curve to the other, it will be noticed, results in a temporary drop in pressure. In order to avoid this drop it is proposed to make the compressor too large for its normal duty—with a characteristic curve as shown at C, Fig. 2—and to make it work as indicated by D by partially closing diffusers. Then, if the two ends are put in series and the diffusers are opened, the curve will be as at E, which intersects D at the working point W. Fig. 3 shows the connection and valves used for changing from parallel to series connection.—*December 21st*, 1922.

TRANSMISSION OF POWER

190,320. November 2nd, 1921.—FLOATING FRAMES for TOOTHED GEARING, *Metropolitan-Vickers Electrical Company, Limited*, 4, *Central-buildings, Westminster*.

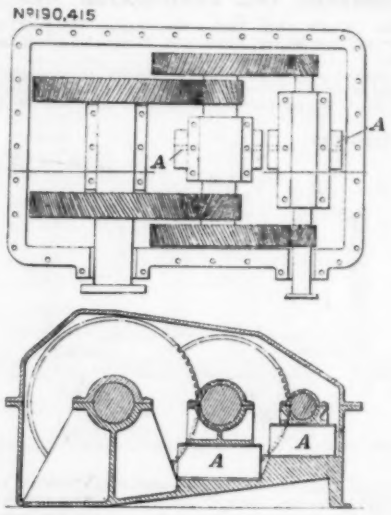
This specification covers an elaborated form of floating frame



for the bearings of high-speed toothed gearing. The pinions A A are supported by bearings, each pair of which is mounted in a frame B. These frames are attached to floating levers C C by means of strut links D, and the floating levers are, in turn, mounted on a main lever E. Pivoted joints are provided between the several parts, while the short lengths of I beam F F F add to the flexibility of the arrangement. An articulated strut G is used to hold the pinion up against the gear wheel. It should be noted that the perspective view shows only one of the two pinions.—*December 21st*, 1922.

190,415. May 10th, 1922.—SPEED REDUCTION GEARING, *A. S. Cachemaille*, 2, *Norfolk-street, Strand*.

With the object of economising space the wheels in this train of reducing gears overlap one another as shown, and they are keyed on to the overhung ends of the shafts. The latter feature also permits the use of a simple form of flexible support for the

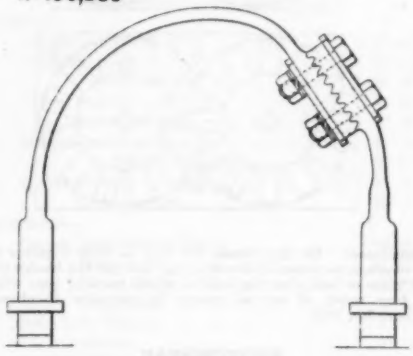


bearings and thus allows the gear wheels to accommodate themselves to inequalities in the tooth pressure. The flexible support takes the form of a short length of I beam, as shown at A A, so disposed that the web can bend slightly and thus adapt itself to differences in the load on the pinions.—*December 21st*, 1922.

MISCELLANEOUS.

190,289. October 10th, 1922.—IMPROVEMENTS IN OR CONNECTED WITH ELECTRIC CONNECTIONS OR COUPLINGS, George Oldham and John Oldham, both of 36, Hyde-road, Denton, near Manchester.

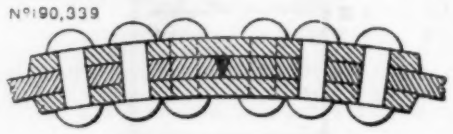
The object of this invention is to provide an improved and simple and thoroughly efficient electrical and mechanical connection or coupling for electrical conductors and other members, which will not become loose as the result of vibration or other



causes. Another object is to provide a connection in which the conductivity between the conductors is greatly increased. As shown in the drawing, these objects are attained by providing the conductors with a number of teeth which interlock in the manner shown.—*December 21st*, 1922.

190,339. November 23rd, 1921.—RIVETED JOINTS, C. E. Tetlow, 33, Carnarvon-street, Hollinwood, near Oldham.

The inventor proposes to make the longitudinal joints of boilers steam-tight by welding the edges of the plates together. He then uses butt straps in the usual manner to provide the



tensile strength of the joint. As, however, the joint is made steam-tight by the welding, the rivets may be spaced farther apart than is possible if they have to keep the joint tight, and they may, in fact, be pitched at the maximum distance permitted by the Board of Trade regulations, with a consequent economy.—*December 21st*, 1922.

CALENDARS, DIARIES, &c.

HENRY SIMON, Limited, Manchester.—This firm has retained its standard type of desk calendar. A plain white background with gold lettering and daily tear-off sheets. At the foot of each sheet is a quotation from some notable source.

THE WELIN DAVIT AND ENGINEERING COMPANY, Limited, 5, Lloyd's-avenue, E.C. 3.—A set of this firm's calendar cards to use in conjunction with its desk stands. On the reverse side of the card a view of a ship fitted with the davits is reproduced.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Lecturette, "k.V.A. and its Measurement," by Mr. G. F. Shotter. 7.30 p.m.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—Mappin Hall of the University, St. George's-square, Sheffield. Paper, "The Heat Treatment of Non-ferrous Alloys," by Professor F. C. Thompson. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Discourse, "The Machinery of Anti-bacterial Defence," by Sir Almroth Wright. 9 p.m.

NEWCOMEN SOCIETY.—Queen's College, Paradise-street, Birmingham. Paper, "Some Notes on Windmills to the Commencement of the Nineteenth Century," by Mr. A. Titley. 6 p.m.

INSTITUTION OF PRODUCTION ENGINEERS.—The Engineers' Club, Coventry-street, W. 1. Paper, "The Principles of Organisation and Management," by Mr. W. Attwood. 7.30 p.m.

INSTITUTION OF AERONAUTICAL ENGINEERS.—The Engineers' Club, Coventry-street, W. 1. Paper, "Wind Tunnel Work at the National Physical Laboratory," by Mr. W. Cowley. 6.30 p.m.

PHYSICAL SOCIETY OF LONDON.—Imperial College of Science, South Kensington, S.W. 7. General meeting. 5 p.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE.—Royal Technical College, George-street, Glasgow. Paper, "The Izod Impact Test," by Professor J. H. Andrew and Mr. R. Hay. 7 p.m.

SATURDAY, JANUARY 27TH.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Neville Hall, Newcastle-upon-Tyne. "Metals Used in Engineering," by Mr. H. Dean. 2 p.m.

WEST YORKSHIRE METALLURGICAL SOCIETY.—City Museum, Leeds. Symposium of papers on "Casting of Metals."

MONDAY, JANUARY 29TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—The College, Loughborough. Meeting of Loughborough graduates. Paper, "Some Notes on Current Motor Cycle Design," by Mr. A. K. Harvey. 7 p.m.

NORTHAMPTON ENGINEERING COLLEGE ENGINEERING SOCIETY.—St. John-street, Clerkenwell, E.C. 1. Paper, "Railway Signals and Signalling," by Mr. G. C. Blofield. 5.30 p.m.

TUESDAY, JANUARY 30TH.

INSTITUTE OF MARINE ENGINEERS.—85/88, The Minories, Tower Hill, E. 1. "Some Deductions from Indicator Diagrams," by Mr. A. Keens. 6.30 p.m.

WEDNESDAY, JANUARY 31ST.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Neville Hall, Newcastle-upon-Tyne. Paper, "Some Experiments on the Throttling of Diesel Engines," by Messrs. H. V. Stead and R. Batie. 7.15 p.m.

THURSDAY, FEBRUARY 1ST.

ROYAL AERONAUTICAL SOCIETY.—Royal Society of Arts, John-street, Adelphi, W.C. 2. "Ten Years' Testing of Model Seaplanes," by Mr. G. S. Baker. 5.30 p.m.

FRIDAY, FEBRUARY 2ND.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Discourse, "Fact and Phantasy in Industrial Science," by Mr. C. F. Cross. 9 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS: MANCHESTER CENTRE.—Visit to the works of Gresham and Craven, Ordsall-lane, Salford. 3 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS: MANCHESTER CENTRE.—College of Technology, Manchester. Paper, "The Theory and Practice of Steam Jet Instruments," by Mr. J. N. Gresham. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Lecturette, "Ventilation and Lighting of Factories" (slides), by Mr. P. J. Waldram. 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, S.W. 1. Informal meeting. "The Use of Light Alloys in Place of Iron and Steel," by Mr. A. E. L. Chorlton. 7 p.m.

MONDAY, FEBRUARY 5TH.

INSTITUTE OF TRANSPORT.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2. Paper, "Wagon Stock on British Railways," by Mr. H. N. Gresley. 5.30 p.m.

TUESDAY, FEBRUARY 6TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Hotel Cecil, Strand, W.C. 2. Annual dinner. 7 p.m.

FRIDAY, FEBRUARY 9TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, S.W. 1. Adjourned discussion on symposium of papers on "Indicators." 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Lecture, "The Effect of Temperature on the Properties of Engineering Materials," by Professor F. C. Lea. 7.30 p.m.

TUESDAY, FEBRUARY 13TH.

INSTITUTE OF MARINE ENGINEERS.—85–88, The Minories, Tower-hill, E. 1. "Internal Combustion and Economy," by Mr. T. D. Madsen. 6.30 p.m.

WEDNESDAY, FEBRUARY 14TH.

ASSOCIATION OF ENGINEERS-IN-CHARGE.—St. Bride's Institute, Bride-lane, Fleet-street, E.C. 4. Paper, "Hydraulic and Electric Lifts," by Mr. C. H. J. Day. 7.30 p.m.

THURSDAY, FEBRUARY 15TH.

ROYAL AERONAUTICAL SOCIETY.—Royal Society of Arts, John-street, Adelphi, W.C. 2. "The Practical Aspects of the Seaplane," by Wing-Commander T. R. Cave-Brown-Cave. 5.30 p.m.

FRIDAY, FEBRUARY 16TH.

INSTITUTION OF ENGINEERING INSPECTION.—Royal Society of Arts, John-street, Adelphi, W.C. 2. Paper, "Chemical Inspection as it Is and as it Should Be," by Mr. H. T. F. Rhodes. 7.30 p.m.

SATURDAY, FEBRUARY 17TH.

WEST YORKSHIRE METALLURGICAL SOCIETY.—Technical College, Bradford. "Cast Iron," by Mr. E. Adamson. 7 p.m.